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NUMBER 1

EXTRADURAL SPINAL TUMORS—PRIMARY, SECONDARY, METASTATIC

By CHARLES A. FISBERG M.D. F.A.C.S. NEW YORK

THE GROUPING AND HISTOLOGICAL STRUCTURE OF THE ENCAPSULATED TUMORS OF THE SPINAL CORD AND MEMBRANES

IT is useful to group spinal cord tumors into those outside of the dura mater—the extradural—and those inside of that membrane—the intradural—and still further to divide the intradural growths into the extramedullary and the intramedullary.

The technical improvement in the operative procedures for the exposure and removal of extramedullary tumors—in which the dura is first incised without injury to the arachnoid—has made it possible to demonstrate at the operating table that some of these growths lie entirely outside of and others inside of the arachnoid.

Intradural extra arachnoid growths may be attached to the inner surface of the dura or only to a nerve root and those within the arachnoid may be adherent only to that membrane to a spinal nerve root or rarely only to the pia mater. A growth attached to a nerve root but otherwise free within the arachnoid cavity may be a true meningeal tumor with an assumed origin from the expansion of the leptomeninges over the root and one presumably derived from the perineurial connective tissue sheath of a spinal nerve root may be adherent to the dura without any visible connection with any part of the root.

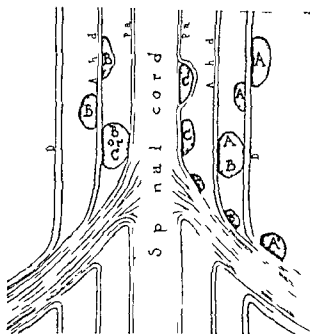
Similar variations may be met with in extradural spinal tumors, a growth of meningeal

origin may be attached to a nerve root or a tumor derived from the sheath of a nerve root may be grossly adherent only to the dura.

The efforts made by many investigators to classify the encapsulated tumors of the nervous system from the standpoint of their microscopic structure have resulted in a wide variety of conclusions regarding their nature and origin and it is therefore not surprising that there is a diversity of opinion regarding the histological features of tumors of the spinal cord.

Antoni in his monograph on 'Rueckenmarkstumoren und Neurofibromatose' uses the terms endothelioma and neurofibroma or neurinoma for the two most common varieties of spinal tumor. On account of a lack of agreement concerning the pathological nature of the meningeal tumors which were variously classified as endothelioma or sarcoma Cushing suggested the name meningioma. This term is descriptive of certain intracranial dural growths but if spinal tumors adherent only to the dura were called by the same name the so called neurofibroma which is sometimes attached only to the dura might from its gross appearance be called a meningioma.

Mallory proposed the name arachnoid fibroblastoma for the tumor commonly called endothelioma and perineurial fibroblastoma for the so called neurofibroma. According to Mallory there is no true endothe-



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lum on the inner surface of the dura the inner layer of which is composed of flattened fibroblasts. He proposed the name "arachnoid fibroblastoma" in order to indicate that the growth originates from and reproduces the general structure of the arachnoid villi.

Mallory studied mainly the cerebral tumor removed by Cushing and in the case naturally it was impossible to determine either at the operation or under the microscope the degree of intimacy of relation between the new growth and the arachnoid.

The conditions within the vertebral canal are favorable for the elucidation of this question. In some of our spinal meningeal tumors we have found the arachnoid entirely free from the growth so that a neoplasm adherent to the inner surface of the dura could be ruled up from the grossly normal arachnoid as soon as the dura had been incised and the cut edges retracted.

In spite of the researches of Harvey and Burr which seemed to show an ectodermal origin of at least part of the meninges the

preponderance of evidence supports the view that the membranes are developed from groups of cells in the perimedullary mesenchyme. It is very probable that the tumors variously called endothelioma, meningioma or arachnoid fibroblastoma are derived from cells which were normally destined to form part of the arachnoid but which remained with the cell groups which finally differentiated into the cells of the dura mater. The occasional occurrence of both intracranial and spinal extradural tumors of the typical endothelioma structure support such a viewpoint (Fig. 1).

In addition to the ordinary staining methods I employed those of Cajal and Del Rio Hortega. In a study of the spinal tumors removed in our clinic he has recently shown that there are distinct histologic differences between the three main types of benign encapsulated tumors of the nervous system—the meningioma, fibroblastoma (endothelioma), meningioma, arachnoid fibroblastoma, the perineural fibroblastoma derived from a spinal nerve root or peripheral nerve (oligodendrocytoma, neurinoma) and the neurofibroma of von Ecklinghausen's disease. According to Penfield, although the first two varieties are fibroblastic they are easily distinguished from each other microscopically because each retains the morphological characteristics of the specialized connective tissue from which it arises. Only in the last group is nervous tissue to be found.

The terminology used by Penfield—meningeal fibroblastoma, perineural fibroblastoma, neurofibroma of von Ecklinghausen—is I think the best that has been hitherto proposed. The differentiation of the von Ecklinghausen tumor from the solitary perineural fibroblastoma constitutes an important advance in the histological classification of encapsulated tumors of the nervous system. The term meningeal fibroblastoma is a happy one because grossly the tumors of this type may be attached to any of the three membranes (see Fig. 1). It is possible that these growths may be derived from dislocated mesenchymal arachnoid cells grouped with either pia or dura mater.

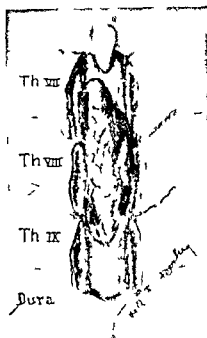


Fig. 2

Fig. 2 Case 17 (N. A. 1196). Showing the appearance upon its exposure of an extradural meningioma (c. 1153).



Fig. 3

Fig. 3 Case 17. Photograph and photomicrograph showing the tumor and its structure (H and E stain X 270).

THE FREQUENCY AND CLINICAL FEATURES OF EXTRADURAL AS COMPARED WITH INTRADURAL TUMORS

Table I includes all of the extradural and intradural tumors exclusive of intramedullary and metastatic extradural growths operated upon in my clinic to September 1927.

TABLE I—EXTRADURAL AND INTRADURAL TUMORS OPERATED UPON TO SEPTEMBER 1927

	Extradural	Intradural	Total
Meningeal fibroblastoma (endothelioma meningioma arachnoid fibroblastoma)	3	72	75
Perineurial fibroblastoma (neurofibroma neurinoma)	5	37	42
Neurofibroma of von Recklinghausen's disease		5	7
Fibroma	1	3	4
Sarcoma	17	8	25
Chondroma	11	0	11
Lipoma	1	3	4
Anoma	2	1	3
Chordoma		0	2
Ependymoma	0	1	1
Leiomyoma	0	1	1
Tuberculoma	1	0	1
Dermoid	0	1	1
Ganglion neuroma	1	0	1
Neuroblastoma	0	1	1
Total	46	33	79

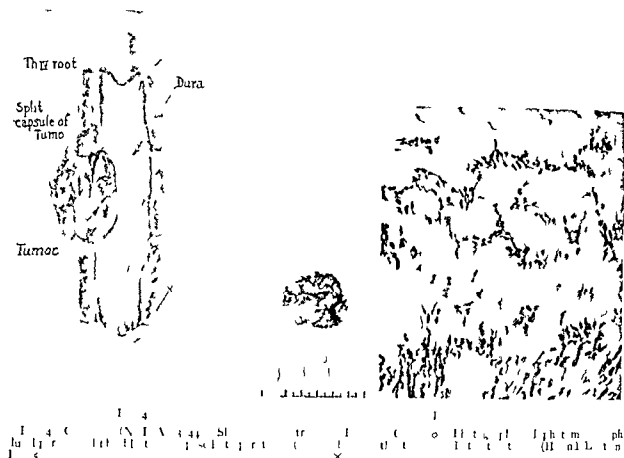
Thus excluding intramedullary and metastatic growths 46 or 26 per cent were extra-

dural and 133 or 74 per cent were intradural. The meningeal and perineurial fibroblastoma formed a large proportion of the tumors inside of the dural sac but they were much less frequent outside of that membrane (8 per cent of intradural and 17 per cent of extradural growths) while the sarcoma and chondroma which formed 61 per cent of the extradural tumors were comparatively rare inside of the dura (6 per cent of intradural extradural growths were classified as sarcoma).

A clearer idea of the relative frequency of the most common extradural and intradural growths can be gained from Table II.

TABLE II—PERCENTAGE OF FREQUENCY OF THE MOST COMMON EXTRADURAL AND INTRADURAL TUMORS IN A SERIES OF 179 CASES (INTRAMEDULLARY AND METASTATIC GROWTHS NOT INCLUDED)

	Extradural	Intradural	All
	P	P	P
Meningeal fibroblastoma	7	54	42
Perineurial fibroblastoma	11	28	23
Sarcoma	37	6	14
Chondroma	4	0	6
Neurofibroma (von Recklinghausen)	4	4	4
Fibroma		2	
Lipoma	2		2



The increase in size of the intradural meningeal and perineurial fibroblastoma which forms per cent of the growth is a slow and gradual one and in most instances the signs of interference with cord function advance slowly. The growths are more infrequent outside of the dura (17 per cent of our series of extradural tumors). On the other hand the sarcomata which are rarely intradural grow more rapidly and either make pressure upon the dura early or more or less suddenly extend into the vertebral canal through intervertebral foramina or by bony destruction. Not so rarely secondary and metastatic extradural growths cause an acute softening of the spinal cord at the affected level through interference with its blood supply.

In the connection mention must be made of another fact which we have found in the study of our extradural tumor. The perineurial fibroblastoma and the neurofibromata of von Recklinghausen's disease as well

as the relatively infrequent extradural sarcomata usually cause slowly progressive cord disturbance while the symptoms due to *extradural* meningeal fibroblastoma progress much more rapidly. In the three cases of our series the interval between the first symptom and marked cord symptom was 1, 1, and 1 month or an average of 4 months.

For all of the cases in the series of spinal cord symptoms in extradural tumor is often more rapidly progressive. Although in many extradural tumor the signs and symptoms of cord involvement progress slowly and in some intradural growth the signs are rapid still in all a short history must make one suspect that the neoplasm outside of the dura.

Local pain is an early symptom does not occur so often in extradural expanding lesion because of the relatively smaller number of instances in which the growth begins in the vicinity of or in close apposition to a nerve root. Not so rarely due to the interposition

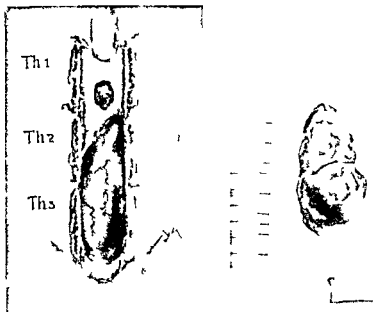


FIG. 6

FIG. 6 Case 12 (N I A 9902) Shows the extradural perineurial fibroblastoma exposed at operation (See Fig. 1).



FIG. 7

FIG. 7 Case 12. Photograph and photomicrograph showing the tumor and their structure (H and E stain $\times 150$).

of the firm dura and of a buffer of cerebrospinal fluid the early spinal cord disturbances have a vague and indefinite character. Sudden exacerbations of signs and symptoms occur relatively often and a flaccid paraplegia occurring within a few days of the onset of weakness of the limbs is seen almost exclusively in malignant extradural disease.

Contralateral motor disturbances, contralateral paresthesias in the lower extremities and the reverse Brown Sequard syndrome (most marked motor disturbances on the opposite side and most advanced sensory diminution on the same side as the tumor) are more often observed in extradural growths.

Changes in the bony structures visible on the X-ray films occur in more than one half of all extradural tumors although in some instances considerable bone destruction is seen at the operation which was not apparent on the X-rays. These bony changes are either an enlargement of the vertebral canal (best seen in lateral stereoscopic views of the spine), a localized defect in one or more vertebrae, a scoliosis at or above the location of the disease, an actual shadow of the new growth or finally a sinking together of the bodies of several vertebrae. In intradural growths bony changes in the X-rays occur rarely except in

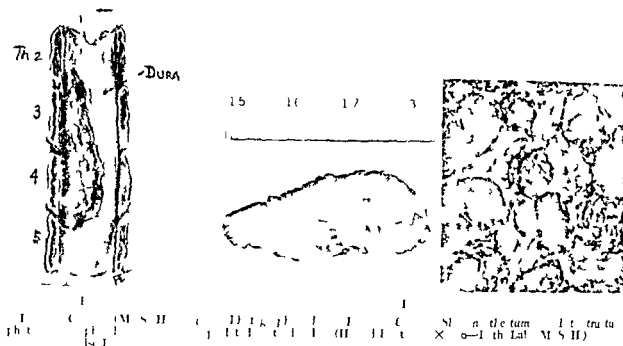
the so called giant tumors of the conus and cauda equina in which an enlargement of the vertebral canal is usually clearly seen on the X-ray films. Occasionally there is a localized arthritis of the vertebrae at the general level of the intradural new growth.

With some exceptions that will be described later on (very small growths such as the ven-



FIG. 8 (left) Case 18 (N I A 12490) Shows a clonoma of unusual form removed from the ventral aspect of the dura (see Fig. 10).

FIG. 9 Case 18. Shows the structure of the tumor (Mallory phosphotungstic acid stain $\times 120$).



trial chondromatous derived from an intervertebral disc (ect.) the manometric study of the spinal fluid have demonstrated a more or less marked spinal subarachnoid block. The fluid obtained by lumbar puncture was often cloudy in color and contained an excess of globulin or total protein although the figure of protein in rose were never as high as in intradural cord compression (*vide infra*).

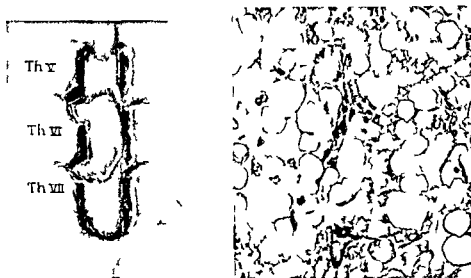
After spinal fluid had been withdrawn by lumbar puncture a distinct and often very marked increase in the subjective and objective signs of cord disturbance was often observed. Oppenheim, Newmark and other once warned of the danger of increase of symptom after lumbar puncture but they made no statement whether this occurred more often in extradural or in intradural growths. In a paper published in 1933 we called attention to the diagnostic significance of such an increase of symptom and stated that it is especially frequent in extradural tumor and in some intradural growths adherent to the dura.

In both extradural and intradural tumor adherent to the dura indefinite level signs not rarely become distinct and motor and sensory disturbance more marked after fluid has been withdrawn from the lumbar subarachnoid space. A careful neurological examination should therefore always be made not only before but also after the puncture.

If the history of the illness is a short one (4 to 8 months) and there are bone changes visible in the X-ray film an increase of signs after the removal of fluid by lumbar puncture usually means that there is an extradural tumor. If on the other hand there is no X-ray evidence of bone destruction and the clinical history one of slow progression the only conclusion that can be drawn from an increase of symptom after lumbar puncture is that a growth—either extra- or intradural—is adherent to the dura.

THE CLASSIFICATION OF INTRADURAL SPINAL TUMORS. THE SYMPTOMS OF PRIMARY SECONDARY AND METASTATIC GROWTHS

Primary, secondary and metastatic extradural growths within the cranial cavity are relatively infrequent as compared with tumors of the brain itself or of cranial nerve or membranes and it is rarely difficult to distinguish between the one and the other.



11, 12 (left) Case 2 (M S H 79954) Showing appearance at operation presented by an extradural lipoma (c 11, 13)

11, 13 Case 22 Showing the structure of the tumor which consists of embryonal fat tissue (H and E stain $\times 40$ —Path Lab M S H)

The conditions are different in the vertebral canal. Compression of the spinal cord by tumors not derived from cord roots or membranes is of frequent occurrence and it is therefore especially necessary to group spinal growths according to their location and the structures from which they originate. In other words a large number of extradural spinal tumors begin in the bony framework of the spine or in the soft tissues which surround the bone. They may be primarily within the vertebral canal or may only secondarily invade the extradural space. The histological structure of these growths is naturally subject to many variations.

The classification of extradural new growths without adequate differentiation between those that are *primarily* extradural and those that *secondarily* extend into the vertebral canal has led to some confusion. Vertebral tumors are often but not always considered apart but not a few growths that originate from the bony or cartilaginous framework of the spine are both in their location and their mechanical effects primary extradural tumors. On the other hand benign and malignant tumors often extend into the vertebral canal at a late period of their growth and they may never affect the dura or the nervous structures within the dural sac.

Most of the tumors that cause cord or root symptoms do so by direct pressure some by

interference with the blood supply and a secondary myelomalacia in still other cases the interference with cord function is due to a sinking together of the bodies of several vertebrae and not to the direct pressure of the neoplasm.

Aside from the grouping of extradural tumors according to their histological structure a classification of these growths based upon their time relation to the vertebral canal is necessary if the variations in their clinical course are to be understood. From this viewpoint extradural tumors may be divided into (1) primary extradural (2) secondary extradural (3) metastatic extradural. Of the 46 cases in our series of extradural growths (not including the metastatic tumors) 4 or 52 per cent were primary and 2 or 48 per cent were secondary.

1. Primary extradural spinal tumors

- a. Growths that arise from the dura nerve roots or epidural fat and blood vessels and are located entirely within the vertebral canal.

The most common forms histologically are
Meningeal fibroblastoma
Perineurial fibroblastoma
Sarcoma
Chondroma
Lipoma
Angioma
Fibroma

Neurofibroma of von Recklinghausen's disease

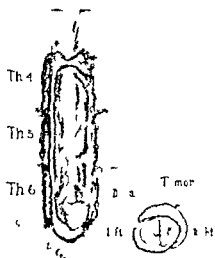


Fig 16

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15 (N I 4 C) Sh ap neural
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t l r l

b. Crotls that arise from the walls of the vertebral canal, the ligament intervertebral artiges and the disc and lie entirely within the vertebral canal.

The most common forms are:

Chondroma of an intervertebral disc

Sarcoma

Osteoma

Secondary intracanalicular

Growth from structure outside of the vertebral canal which secondarily invade the extracanalicular space.

Sarcoma of the soft tissues of the back or

the bony part of the spine

Chondroma of the vertebra

Chordoma

Chondrosarcoma

Myeloid tumor

3. Metastatic intracanalicular

Carcinoma metastasizing from the vertebral root

Primary vertebral intracanalicular

Sarcoma (chondrosarcoma)

Hypernephroma

Myeloma

Lymphoma of the lymphatic system

only may have begun in the vertebral canal before it invaded the extracanalicular tissues and therefore was actually a primary extracanalicular growth. With this reservation the above classification should avoid some of the confusion regarding the symptom and course of extracanalicular tumor that has occurred in the past.

PRIMARY EXTRACANALICULAR TUMORS

a. From dura, nerve root or epidural fat infiltration. With the exception of one of the dural sarcomata which are not well encapsulated most of the growth in this group arise from dura or nerve root and have a good capsule. In size and in gross appearance they are very like the typical intracanalicular growths - 1 to 4 centimeters in length and 1 to 2 centimeters in width and often loosely adherent to the surface of the dura (Fig. 3A, 5A, 11A). In the intracanalicular growths they are most often found on the posterior or lateral aspects of the dural sac. The tumors are usually single meningeal fibroblastoma (Fig. 14) and 3: perineural

There are inherent possibilities of error in this classification. Some tumors derived from bone or cartilage which would be included in the primary group may have begun within the substance of these tissues before they extended into the vertebral canal and they might therefore actually belong to the secondary growths likewise a tumor classified as sec-

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f h h f l d f t m l t h h l t h h d
m h t l

fibroblastomata (Figs 4 and 5) fibromata angiomatica or lipomata

In one instance (Figs 6 and 7) there were two distinct perineural fibroblastomata adherent to the dura but not grossly connected with any nerve root but if more than one tumor is met with one must think rather that the growths are neurofibromata of von Recklinghausen's disease in which multiple encapsulated growths both outside of and within the dural sac are frequent

One chondroma included in this group was well encapsulated and loosely adherent to the dura. The tumor was of bizarre shape it lay on the ventral aspect of the dural sac not connected with bone or intervertebral cartilage and was loosely attached to the dura (Figs 8 and 9). This one chondroma is included in this group because it was entirely different from the ventral chondromata derived from an intervertebral disc and from the secondary extradural chondromata to be described in another part of this paper

In two patients encapsulated tumors loosely attached to the dura had the gross appearance of extradural meningeal fibroblastomata but histologically the growth was made up of a mass of small blood vessels with no microscopic evidence of the type structure of the meningeal fibroblastoma (Figs 10 and 11). Extradural lipomata are rare and there was only one example in our series. In this patient the growth was part of a generalized lipomatosis—an *adenolipomateuse symétrique*—and the microscopic study (Klemperer) demonstrated that the growth consisted of embryonic fat tissue (Figs 12 and 13).

The average length of time that elapsed before there were more or less well marked motor and sensory cord disturbances was between 16 and 17 months but there was considerable variation in this respect between the different varieties of new growth.

In the fibromata perineural fibroblastomata and the angiomatica the average period from first symptom to operation was 17 months in the primary chondromata it was only 13 months and in only 2 of the 7 patients was the history of more than 1 year's duration. The course of the extradural meningeal

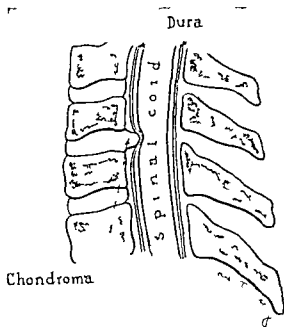
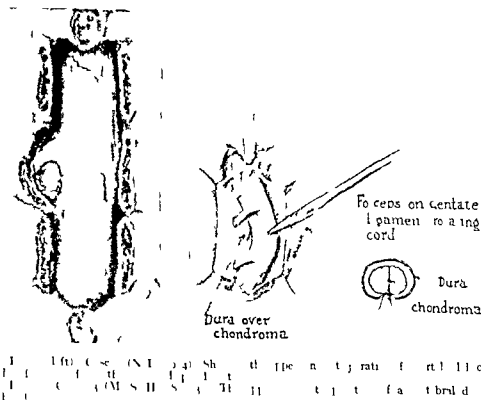


Fig. 17. Shows the usual location of a ventral vertebral disc chondroma.

fibroblastomata in our series was a remarkably rapid one with an average of only 4½ months from the beginning of symptoms to the time of marked cord involvement.

In many of these patients the clinical picture was so similar to that of an intradural tumor that the diagnosis extradural tumor could only rarely be made with any degree of certainty. The course of the comparatively infrequent primary dural sarcoma may also be slowly progressive. A more or less prolonged period of pain in the back not characteristically radicular in character followed by rapidly advancing signs of disturbance of cord function are however outstanding clinical features of secondary and metastatic extradural tumors.

In the benign encapsulated growths increase of cord symptoms after withdrawal of fluid by lumbar puncture occurred in almost one half of the patients no matter whether the manometric tests showed a complete or only a partial spinal subarachnoid block. If the records in many of our earlier and some of our later cases were complete the percentage would be a much higher one probably 75 per cent. Ananthochromia does not occur so often as in intradural tumors and the increase of globulin or of total protein was never so high as in intradural growths. In



most of the case the total protein was 50 to 60 milligram and only slightly above the normal and the highest protein content was 150 milligram. In one patient with an extradural fibroma the spinal fluid was normal in all respect.

The primary extradural sarcomata occur in two distinct forms. In one variety the tumor is encapsulated more or less firmly attached to the outer surface of the dura does not become adherent to the wall of the vertebral canal and rarely extend outward through intervertebral foramina. The predominant character of the form of extradural sarcoma is to extend along the surface of the dura and especially to more or less completely surround the spinal sac. Not rarely there is a large amount of tumor tissue on the ventral aspect of the dura. The upper and lower limits of these growths can often be exposed by the removal of the arches of two or three vertebrae and the firm reddish brown tumor can usually be peeled off from the dura (Fig. 14) perhaps with a layer of that membrane. In some instances a growth that from its gross character appears to be a sarcoma is

found on microscopic examination to be a meningeal fibroblastoma (endothelioma). In our case the growth was very cellular and did not contain the typical whorls (Fig. 15).

Some primary extradural sarcomata although well encapsulated extend along the dura for a considerable distance so that their upper and lower limits can not be exposed at the operation and they may as in one case of our series extend from the cervical to the lumbar regions (diffuse sarcoma of the dura). The extensive growth retains the characteristic that they do not become adherent to the wall of the vertebral canal.

The second variety of primary extradural sarcoma occurs as a well encapsulated tumor which extends beyond the confines of the vertebral canal through intervertebral foramina or by bone destruction.

The growth is in shape of a larger mass and in many cases whether the extradural growth

The growth is apart within the vertebral canal is difficult to begin as a whether the



Fig. 15 (left) (Case No. 11, 1925) Showing the tumor at the base of the neck in a child of cerebral tumor.
 Fig. 16 (right) (Case No. 12) Illustration of the extradural tumor into the vertebral canal in the same patient as in Fig. 15.

extradural part was secondary (Fig. 16) Boerner, Guleke and Borchardt have called special attention to the dumb bell shaped tumors which begin outside of the dura within the vertebral canal. In several of their cases the primary extradural origin of the growth was proved by the fact of outgrowths through two intervertebral foramina.

The clinical course of this form of extradural sarcoma does not differ from that of the first variety excepting that bone changes are more frequent.

b. Tumors which arise from the vertebral or the inter vertebral cartilages and lie entirely within the vertebral canal. In our series there were 7 instances of chondroma derived from an intervertebral disc.

The intervertebral disc chondromata have been recently studied by Dr. Stookey. They are small hard growths no more than 1 to 1½ centimeters in length which originate from and are firmly fixed to the anterior wall of the vertebral canal probably always from an intervertebral disc (Fig. 17). They have been found only in the cervical region and compress the dura from its ventral aspect either in the midline or more to one or the other side.

In none of our cases was there any bone changes visible on the X-ray films.

The clinical history may be a short one—less than 6 months or of 1 to 2 years duration. In one of our patients the prominent symptom was pain referred to the distribu-

tion of one sensory root and at the operation the tumor was found just underneath the affected nerve root (Fig. 18). In all of the other cases the subjective and objective disturbances pointed to a progressive compression of the cord from its ventral aspect (paresthesias and dysesthesias referred to the lower limbs, marked unilateral or bilateral diminution of motor power, sensory diminution which involved especially pain and temperature sensibility and was some times of the Brown-Sequard type).

The manometric tests showed that there was a complete subarachnoid block in 2 patients and a partial block in 1 while in the others there was no demonstrable interference in the pathways of the spinal fluid substantiated in 1 patient by a lipiodol injection. With one exception the fluid removed by lumbar puncture showed neither a change in color, in globulin or protein content or in the number of cells.

In every patient in whom there are the evidences of a localized and slowly advancing involvement of the spinal cord in the cervical region in whom X-ray is negative the spinal fluid normal and the manometric tests negative or almost negative the possibility of a ventral intervertebral disc chondroma must be kept in mind.

These ventral chondromata are probably much more common than we have hitherto believed and vague symptoms referable to

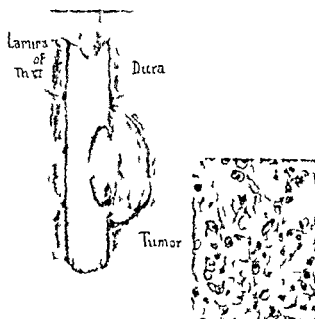


Fig. 1. A diagram and a histological section. The diagram shows a cross-section of the spine with labels: 'Lamens of Vert' (vertebral laminae), 'Dura' (dura mater), and 'Tumor' (a large mass within the vertebral canal). The histological section shows a microscopic view of tissue with many small, dark, circular structures.

one or more element of the cervical cord may in the future be shown to be not strictly due to a very small cartilaginous outgrowth on the ventral aspect of the dura. The tumors are so small in size and in such a location that they can be easily missed unless the exploratory material by an experienced neurosurgeon and they can often be found only after the dura has been opened and the cord rotated and drawn over the bony structure on the distal half of the dentate ligament. The small prominence of the tumor near the midline can sometime be felt with the exploratory probe after the dura has been opened and can always be seen when the cord has been drawn to one side (Fig. 10).

2. SECONDARY EXTRADURAL TUMORS

The growth that begin outside of the vertebral canal and secondarily extend into it—rarely through intervertebral foramina but more often by bone destruction—are either clinically and histologically malignant or benign. The growths may originate from any of the tissue around or at some distance from the vertebral canal from the perosteum or from the bone itself from ligaments

muscles or their fascial coverings from spinal sympathetic ganglia or from nerve sheath growths in the posterior mediastinum or in the thorax (ganglion neuroma sarcoma or endothelioma of the pleura hydatid cysts) may extend into the vertebral canal and compress the spinal cord through the dura. We have seen 5 instances in which progressive cord disturbance were due to the extension into the vertebral canal of a large intrathoracic growth visible on the X-ray films. Two of the patients were operated upon and the nature of the growth verified. One was a sarcoma and the other a ganglion neuroma.

The variety of tumor described by Flatau and Sawicki under the name of cervical neurofibroma begin from nerve sheaths outside of the vertebral canal and invade both the deep tissue of the neck and the spinal extradural space. In these patients there is a palpable or visible mass at the root of the neck connected with a smaller mass outside of the dura (Fig. 11). The malignant chordoma which originates from the remnant of an embryonic notochordal structure the notochord usually begins in the body of a vertebra or within an intervertebral disc and secondarily extend into the vertebral canal.

In some instances condylary malignant growth never invade the vertebral canal and therefore do not make any pressure upon the dura and in these patients the spinal cord symptoms are due either to interference with the vascular supply of the cord or to the interference of the bony growth or one or more vertebrae with irregular compression of the cord segment at the level of the disc. They occur however more often with metastatic than with condylary new growth.

The tumors that have extended into the vertebral canal from the outside are usually more or less hourglass or dumb bell shape.

A larger mass outside being connected with a smaller part of the growth on the outer surface of the dura (Fig. 12 and 13). In some of the condylary sarcomata and in the chordoma the growth is primarily located in a vertebral body and its extension into the vertebral canal lies in front of the dorsal sac. More often however the extradural part of the tumor lies on the lateral aspect of the

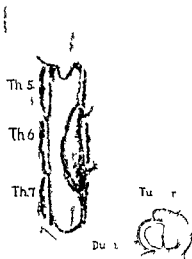


Fig. 4

I 24 Ca 43 (N I 9539) Acl orl ma expo d
at the operation (I 1 5)



Fig. 25

I 24 Ca 43 The structure of the tumor shown in
Figur 24 (A $\times 160$ B $\times 310$)

dural sac and extends both on the posterior and the anterior surfaces of the dura

Some of these secondary growths are well encapsulated and the mass outside of the vertebral canal lies in a bone cavity with smooth walls but more often the part within the vertebral canal has a distinct capsule while the primary part of the growth is not well limited by a membrane

In about 5 per cent of the secondary extradural tumors the development of spinal cord disturbances is a gradual one and from 1 to 3 years elapse before the cord disturbances are well marked. If it were not for the X ray findings of more or less marked bone destruction the differentiation of these from primary extradural and intradural tumors would be difficult. In the remaining 77 per cent of our cases pain in the back lasting for a shorter or longer period was followed by an advance of spinal cord symptoms more rapid than is seen in intradural growths

In 17 of the 22 patients with secondary extradural tumors the spinal symptoms were of less than 1 year's and in 10 of these of 6 or less months duration

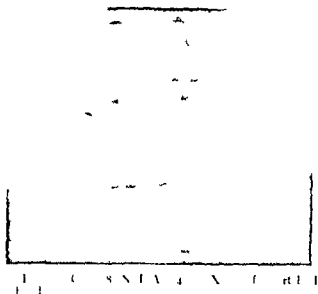
If the patient is seen during the period when the tumor is still outside of the vertebral canal and when he is suffering only from pain in the region of his disease there may be no bone changes visible on the X ray films and

the manometric tests of the spinal fluid pressure may be entirely normal. On the other hand with negative spinal fluid findings the X ray evidence of bone destruction may point to the nature of the disease

The more acute development and the more rapid advance of the signs of spinal cord involvement in most of the secondary sarcomata is easily understood when one takes into account the more active growth of the tumor and its sudden extension into the vertebral canal

In 85 per cent of the secondary sarcomata the interval between the first symptom and the operation was less than 1 year—on the average between 4 and 7 months

That a slowly growing tumor such as the chordoma will cause slowly progressive symptoms is to be expected but it is surprising that the course of the two malignant chordomata in our series was a comparatively slow one. In the 2 cases operated upon by the writer the interval between the first symptom and the operation was 10 months in 1 and 1 month in the other patient—a duration no shorter than that seen in many benign intradural and extradural growths. One of our patients with the growth in the mid thoracic region (Figs 24 and 25) had a slowly advancing spastic paraplegia in the second case the growth lay in front of the



root of the caudal equine at the level of the first and second lumbar vertebrae and had marked caudal equine syndrome.

In all of the secondary extradural tumor, excepting the chordoma, there was distinct evidence of bone destruction in the X-ray film. The X-ray evidence of the chordoma is characteristic (Fig. 81) but in one case the roentgenogram outlined a growth which had not the typical appearance of a chordoma. The operation exposed a lumbar bony cartilaginous growth (Fig. 82) which was removed completely in fragments.

The changes seen in the X-ray are more often detect in part of the bodies, arches or lateral masses of the vertebrae. The defect may not only indicate the amount of bone destruction but very clearly outline the growth (Fig. 83). The defect is usually more extensive than the X-ray change would indicate.

The alteration in the spinal fluid and in the manometric tests are similar to those found in primary extradural growths.

3. METASTATIC EXTRADURAL TUMORS

Extradural metastasis from primary malignant disease of the breast, thyroid, prostate or gastrointestinal tract have been studied and reported upon by many writers. They are considered here only because they should be strictly separated from other extradural

growths—a fact which has not always been done in papers on extradural tumors.

The metastasis is most often located in or on the lateral aspect of the bodies of the vertebrae and results in more or less extensive bone destruction visible on the X-ray film.

A period of pain in the back usually made worse by the slightest movement precedes the appearance of disturbances of cord function. Although a slowly progressive spastic paraplegia may occur a rapid progress with complete flaccid paraplegia within a few days is more frequent. The cord symptoms may be due to the rapidly increasing pressure on the dura of the new growth but in many instances the amount of tumor tissue within the vertebral canal is small and the cord symptoms are due to a sudden myelomalacia from profound disturbance of the blood supply or to the sudden collapse of the bodies of one or more vertebrae.

The spinal metastasis may occur many years after the primary growth has been removed. This happened in one of our patients with a metastatic melanoma in whom an excised had been removed 14 years before for a primary tumor of the choroid.

Metastatic tumors may cause only severe root symptoms but more often the disturbances of cord function are well marked. Motor disturbances below the level of the lesion may be profound at a period when there is no or only very light sensory loss. The symptom of a complete transverse lesion of the cord are however very frequent.

Although myeloma is really a part of a multiple disease it is extradural lymphoma in Hodgkin's disease and metastatic lymphoma they may be included in the group of metastatic tumor. We have seen one example of each of the two tumors. Whenever there is X-ray evidence of bone destruction without a clear history of a primary malignant disease in some other part of the body the urine should be examined for Bence Jones albumin in order to exclude myeloma.

THE SURGICAL TREATMENT OF EXTRADURAL TUMORS

The technique of the exposure of primary localized extradural tumor unless they have



Fig. 27. Case 4 (N I 13 68). Unusual view appearance of a secondary extradural chondroma.

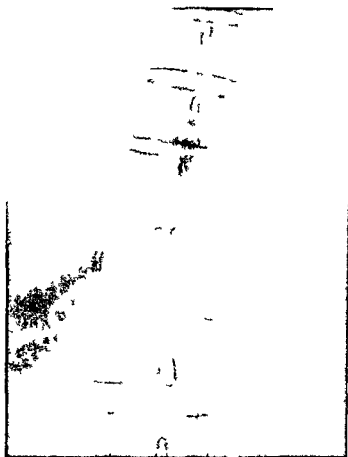


Fig. 28. Case 4 (N I 13 68). Another view of the same extradural tumor, showing the exact size and shape of the growth.

extended beyond the confines of the vertebral canal does not differ essentially from that for intradural growths with the exception that the dural sac must often not be opened.

The approach to the ventral vertebral disc chondromata has to be made in most instances transdurally. The transdural approach was described by the writer many years ago because of the difficulties in the recognition and the exposure and removal of these small midline growths by the extradural route. The dura is exposed and incised and the cord is rotated and drawn to one side by traction on a divided slip of the dentate ligament. The bulging dura over the ventrally located growth is then incised and the chondroma which is firmly fixed to the anterior wall of the vertebral canal is removed in layers with a sharp curette. When all of the cartilaginous mass has been removed by this fragmentary excision the dura will fall into

the tumor bed and suture of the incision in the ventral dura is unnecessary.

During the manipulations the greatest care must be taken that the cord is not traumatized and as it is always in plain view this can be accomplished without special difficulty.

This transdural procedure (Figs. 19-30) may also be useful for the exposure and removal of other small ventral chondromata not derived from an intervertebral disc and of small chordomata.

The removal of extradural tumors which surround more or less of the circumference of the dural sac is often unsatisfactory because the ventral part of the growth may be so extensive that only an incomplete fragmentary removal is possible. Not so rarely there is considerable disturbing bleeding from the veins on the posterior surfaces of the bodies of the vertebrae which requires frequent packing with cotton balls soaked with hot saline solution or with adrenalin. In order to obtain a good exposure the laminae on one side

has been due to the inclusion in one group of not only the primary but also the secondary and often the metastatic growths.

Spinal metastases are from their nature practically always irremovable and as in all metastatic growths should only exceptionally be attacked surgically. If metastatic growths are excluded almost 50 per cent of extradural tumors are benign in nature and technically removable and therefore in at least one half of patients with extradural growths complete eradication of the disease is possible. In addition some of the primary and secondary encapsulated sarcoma can be completely removed.

The end results in the 46 patients of our series can be seen in Tables IV and V.

The dangers of the operation in patients with extradural neoplasms are not much greater than that of laminectomy for intradural tumors or for other diseases. In 3 of our 46 patients or 7 per cent death was due directly to the operative procedure. One patient, operated upon many years ago, a child of 3 years with a secondary ganglion neuroma died from shock after the removal of a large encapsulated growth. The second fatality was in a case of ventral chondroma. The patient's wound was healed and she had improved very much weeks after the operation when she died suddenly from a pulmonary embolism. The third patient unfortunately succumbed to a wound infection 2 months after the operation.

Table III shows the results in 34 patients the 3 operative fatalities and 9 cases in which operation was done less than a year ago having been excluded.

SUMMARY

1 Exclusive of intramedullary tumors and of metastatic extradural and intradural growths about one fourth of all spinal tumors are extradural.

2 The meningeal and perineurial fibroblastomata constitute 17 per cent of the extradural and 82 per cent of the intradural tumors the sarcomata and chondromata 61 per cent of extradural and 6 per cent of intradural growths.

3 In general the clinical course of extradural tumors is more rapid sudden exacerba-

tions of symptoms not unusual, exaggeration of symptoms and signs after withdrawal of fluid by lumbar puncture very frequent. The early symptoms are often vague in character root pain infrequent, contralateral motor disturbances and contralateral paresthesias and the reverse Brown Squirrel syndrome often observed. The increase of globulin or total protein is rarely if ever as marked as in intradural tumors and in many of the vertebral disc chondromata there is no evidence of subarachnoid block by the manometric tests.

4 Extradural tumors should be divided into primary secondary and metastatic. Exclusive of the metastatic growths 5 per cent were primary and 48 per cent were secondary.

5 Many of the primary extradural growths are benign and encapsulated and completely removable. The meningeal and perineurial fibroblastoma the fibroma angioma and chondroma are usually single. The primary extradural chondroma occurs in two forms. In the one the growth lies in the extradural space on the ventral or dorsal aspect of the dural sac in the other the growth is derived from and firmly fixed to an intervertebral disc.

The primary extradural sarcomata occur in two forms. Either the growths are derived from the dura and have no tendency to become adherent to or involve the walls of the vertebral canal or they begin within the canal and erode the bone and grow outwards forming hour glass or dumb bell shaped tumors.

6 The secondary tumors grow into the vertebral canal either through intervertebral foramina or by bone erosion. They arise from the vertebral or paravertebral soft tissues and may be extensions of growths in the thorax or deep tissues of the neck or back. The spinal cord symptoms are due either to the pressure of the extradural part of the growth or to interference with the blood supply of part of the cord and the symptoms are excepting in the chondromata more acute in their onset and more rapidly progressive. The chordomata are true secondary extradural tumors although their clinical course was as slow as that of many benign extradural and intradural tumors.

T A B L E V — S E C O N D A R Y T U M O R S

C N	Age	D t d t m p t m	M t r s p l m	S y m p t m	D t d t f r t	N t f t m	L l	R l t	I t l t
N I 489	5		T t i g	T t i h t p m k l	I 3 ⁹ Q m l f f l i d t m R f d l	f l m	L V I V I I I	C t m r m t	I g e l p e t (D R f 4 j—g l L g f r 53
N I 5			p a t p i g	C m p l t l t	J 13 ⁹ Q d h 5 m l f t	f l m	L V V I	N m p	D e d j e a l t f m p l m r s t b e l o c
N I 767			S p t i l	M k e d	J l 13 ⁹ m l f p i t l t	(g l f m h	L V I V I	D t h	S h k f t p t
5	50	9	p p p l g	M k e d	A 3 m t m l	K l e d f m	L V V I	G m	W l 73 f t p e
N I 9	5	6	S p t i l f b	M k d	N 1 f l l	f m h	L V V I I I	N m	L k l b d e d t h f p t
M H 1	6		M t i p	M k d	M l f l	f l m	L V	C m p	W l 73 f t
N I 3	6	6	F t f l	M k l	I 13 ⁹ m l f m	m	L I I I V I	N m	D e d h 3
N I 309	9	4	F t f l b	T p l m	M h 13 ⁹ m l f g m l	m	L V I I I	M k l	I l f m l m t t
N I 38	6	6	F t p p l b	M k d	M h 13 ⁹ f p i t l	N	L V I I I I I	M k l m	l o c t p t l l d t
N I A 35	3	7	I l d t f l b	l b	J 33 ⁹ m l f l m l	(f l b m	L I I I V I	L t f m t	I l l 33 p o t
N I 311	5	7	p t i l	M k d	I m l f m m l		L V I I I	l h m p	I t l t
N I 643	57	4	S p t i a r i g	M k d	I b m l f 4 t 3 l		L V I	L t d m	D d 3 f t
M S H 6	3	4	l b b i	l b t	F l g m 9 m l	(l f m	L V I I I	W l	33 f t t u
N I A 410	9	3	M k e d l	l g h	p l m l f t l 6 f t l 6 f b l 7	(l f m	L V I I I I I	I 33	f l f t m p
N I 306	6		N l g h t	l b t	O 7 0 4 t m 9 m d		L V I I I	l h m r	D t f l t h l
N I 786	3	3	S p t p p l	M k d	f 3 5 p l f m t l	m l 3 t m h e s t	L I I I V I	N t m r	l s m t h
N I A 4	9	36	N	l b t	J l 9 f g m t m p t m l	(h l m	L V I I I I I	C l b l	l b l t k f i d l h
N I 18846	8		M l i p t p l g t	N l h t	M l 9 M l 9 m l f m l m l	f b m	L V V	t t m f	W l 5 m t h l
N I 10319	57		S p t p p l g	M k l	M y 4 k t o 0 7 d p l	l h m	L V V I	N m r	D l m t h l t
44	63		k t d p l b	I l y m k d	J 4 0 6 m l f r g m t y t l l	C h d m	L I I I	N m r	D l 6 m t h f t
N I 31363	63	36	M k l p t p p l t	M k l	D m b e 7 19 6 m l f t l	C h d m	L V I I I I I	W l	3 m t h
N I 5348	50	6	M d i p t l p l g	T t l m p t m d	S p l 3 f g m t m l	(f h	L V I I I I	G t m r	5 m t h l l f g f m o o p

7 The spinal cord symptoms of metastatic extradural growths are usually rapidly progressive and bone destruction visible on the X rays is very frequent. The symptoms are often due to interference with the blood supply of part of the cord or to the collapse of the bodies of one or more vertebrae.

8 The clinical course of the various types of extradural tumors was described and their gross and histologic structure illustrated.

9 Most of the primary and many of the secondary extradural tumors can be completely removed. Some features of the surgical technique were discussed. The cases in which craniotomy operation is preferable were described and the technique of intradural removal of ventral extradural growth was illustrated. The complete removal of metastatic and of some primary and many secondary extradural tumors is impossible.

10 More than one third of patients with primary or secondary extradural tumor can be greatly improved or permanently cured. The proportion is larger in the primary than in the secondary and in benign than in malignant tumor.

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9. C. C. H. A. I. N. L. b. e. r. I. l. S. n. d. l. g. s. c. h. u. l. t. n. I. W. l. l. u. l. k. l. r. n. C. u. p. i. W. i. l. l. k. m. n. A. l. f. l. l. n. C. l. j. e. 933. H. A. V. I. V. S. C. I. B. R. H. S. T. h. l. l. j. m. t. d. t. n. A. l. N. l. & I. 3. I. t. 9. f. v. 54. M. L. Y. I. B. H. t. I. l. l. f. t. h. l. l. d. d. r. a. l. n. l. t. h. i. m. J. M. I. l. h. j. o. l. 330. N. E. W. I. A. R. I. U. l. m. A. n. H. a. d. i. l. u. m. b. a. l. I. u. k. C. n. t. r. t. i. l. / i. a. h. m. f. K. m. p. I. m. u. l. t. a. m. j. l. l. R. k. e. n. m. k. t. n. B. l. l. l. W. h. h. 9. 4. I. 3. N. A. I. M. W. t. I. f. l. l. r. u. m. k. p. t. l. d. r. D. n. s. n. k. m. j. m. n. l. n. I. u. k. m. k. t. u. r. B. l. k. l. W. l. c. l. 9. 3. 94. I. n. r. v. W. C. T. h. c. a. p. l. t. f. t. m. r. s. o. f. t. h. n. r. v. t. m. S. r. k. C. v. C. O. l. t. 10. I. I. t. I. l. k. l. D. r. A. C. l. d. m. m. l. n. d. I. i. d. l. r. j. n. j. I. l. l. t. m. m. S. o. A. t. d. I. 9. 4. 38. I. 3. C. J. B. t. t. b. r. l. t. m. p. r. o. l. I. v. j. t. m. f. t. t. n. l. r. d. p. r. t. f. t. l. I. 3. J. N. l. C. I. b. j. t. l. 9. 4. 5. 2. S. T. K. Y. B. I. j. p. f. n. t. i. f. r. a. l. d. s. e. h. n. l. n. I. A. m. N. l. A. 9. 8. T. A. t. R. A. S. U. l. t. I. l. m. t. o. m. y. F. l. n. c. I. W. l. r. W. l. l. I. D. t. l. d. W. e. l. h. 90. 1.

THE INFLUENCE OF FIBROIDS ON PREGNANCY AND LABOR¹

By JOHN OSBORN, IO L A K A N D I A C S B R O O K L Y N N E W Y O R K

FIBROIDS produce a relative degree of sterility either by impairing fertility or by favoring the early termination of conception by the production of abortion. Conversely it may be stated that the barren uterus is more prone to the development of fibroids than the uterus which is alternately going through periods of hypertrophy and involution. Nearly one third of the patients who are the subjects of this form of neoplasm remain sterile. The most important clinical fact relative to sterility and fertility is not that the uterus contains a fibroid or fibroids—but what is their location and size? The probable explanations of why fibroids affect fertility and predispose to abortion are

a. The disturbance in the normal menstrual cycle due to circulatory changes which affect the endometrial surfaces contiguous to the fibroid. This is particularly evident in submucous and interstitial growths which are of sufficient size or in such a location as to distort the contour of the uterine cavity and produce atrophy or hypertrophy of the lining mucosa.

b. In addition to this inability in embedding the ovum there is further added an increased muscular activity of the uterine contractions which are constant and tend to evolve the tumor in the direction of least resistance inward or outward depending on its relation to the musculature. This state of intermittent contraction is therefore unfavorable for the growing ovum. This is illustrated by the fact that in the author's series 21 per cent of the pregnancies occurring in fibroid uteri have terminated in abortion or premature labor. This is a slightly lower incidence than that reported by Fiskson of 4 per cent but higher than that of Finnerd with 15 per cent. According to Scarpides pregnancy with myoma results in abortion or premature labor in fully 50 per cent of the cases.

Not only do fibroids influence the growth and the development of the pregnant uterus but pregnancy has a like effect upon the

fibroid as in pregnancy the uterus is increased in size—this is not only due to the increasing bulk of the developing ovum but also to the more abundant blood supply and an actual hypertrophy of the uterine muscle. Likewise fibroids which have their nutrition increased will grow more rapidly and take part in the general succulence and hypertrophy of the contiguous structures. *It is however their location which will determine their effect upon the particular pregnancy* remembering that all tumors in the uterine wall are evolved in the direction of least resistance one can readily see how a subperitoneal tumor with a sessile base which may develop near the fundus may under the influence of pregnancy and its increased blood supply rapidly enlarge and fill the greater part of the abdomen at times reaching the ensiform or by uterine contraction be extruded beneath the peritoneum become pedunculate twisted and necrose—and yet have little effect upon the pregnancy which is growing within the uterus. On the other hand a tumor in such a position may by its weight displace the uterus backward and incarcerate it in the pelvis in such a way as to produce circulatory disturbances blocking the venous return producing nerve pressure and edema—the latter not only in the tumor but in the covering and contiguous peritoneum with consequent adhesions. Such a development resulting from incarceration must necessarily either end in abortion or in the anomalous development of the ovum in the anterior uterine wall.

Should this same tumor be situated near the fundus and have an interstitial location its influence on the development of pregnancy would be entirely different for while it might distort the uterine cavity unless it became submucous it would have no effect on the endometrial lining—hence we see many pregnancies complicated by interstitial tumors which go to term without producing any abnormal symptoms. This however is not true in submucous growths which are naturally

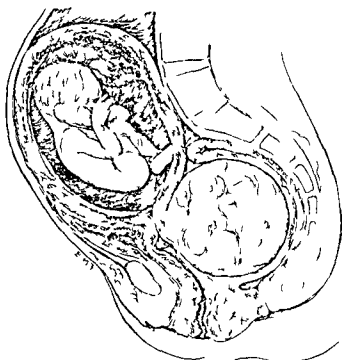


Fig. 3. Incarcerated myoma of lower segment posterior wall making intravaginal delivery impossible.

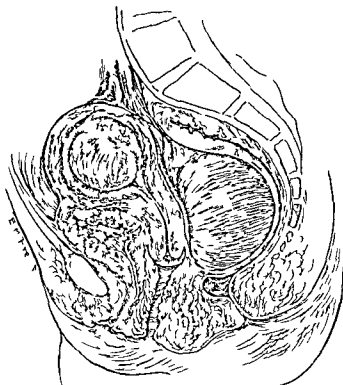


Fig. 4. Two-lobulated subserous tumor incarcerated cesarean followed by myomectomy.

or dry labor but cause uterine inertia and mechanical dystocia. Lynch in a review of this subject by a study of his material at the University of California found an incidence of cephalic presentation in 50 per cent breech in 22 per cent transverse in 18 per cent. This means that labor must be more complicated as even a cursory examination of Lierson's excellent table will show. He reviewed the histories of 30,000 labors at the Sloan Hospital for Women and from these he collected 50 cases in which the fibroid tumor was of such a size as to have clinical consideration in the course of pregnancy or labor and then compared the obstetric accidents and abnormalities occurring in this series with those occurring in 8,300 consecutive unselected cases.

These statistics are in line with the personal experience of the writer and should direct the attention of obstetricians to the necessity of correcting the statement so commonly made in textbooks, i.e., although the association of fibromyomata and pregnancy is a relatively frequent one disturbance by them of the normal course of pregnancy and labor is unusual. Certainly we cannot subscribe to

such a statement for any condition which increases the average incidence of abortion or dry labor operative interference postpartum hemorrhage and fetal and maternal mortality from 3 to 6 times the average deserves a more careful clinical consideration. Furthermore while fibroids have these unfortunate effects on pregnancy pregnancy likewise has an important influence on fibroids for a relatively large percentage undergo some degeneration resulting from circulatory stasis.

Sneed states that 15 per cent of fibroids undergo some form of degeneration during pregnancy. The increased blood supply which is concomitant produces such circulatory changes in the tumor as hypertrophy hyperplasia and increased vascularity therefore all fibroids grow more rapidly under the influence of pregnancy. These tumors become more prominent or flatten out or they may alter their shape and position due to change in location and axis.

During gestation and the puerperium the tumor may undergo necrobiosis or red degeneration oedema or necrosis. Red degeneration is a partial death of the tissues within the tumor with hemorrhage into the growth (a

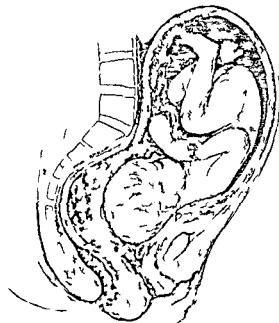
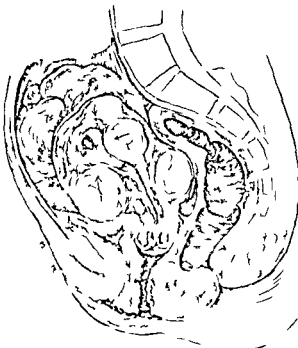


Fig. 1. Necrotic degeneration of the tumor.

Fig. 2. Necrotic degeneration of the tumor.

partial or complete necrosis of the tumor is usually surrounded with sufficient healthy tissue to recover. In the form of degenerative change the red blood cells are hemolyzed and the blood pigments unite with necrotic cells. This complication is more common in interstitial growths since in these there is lessening of the blood supply owing to the intermittent contraction of the uterine muscle which is constantly attempting to evolve the growth in the direction of least resistance. These contractions more or less free the tumor from its surrounding capsule and leave it in a place in which the blood supply may be inadequate.

Infected degeneration occurring during pregnancy presents a typical symptom complex. There is sudden pain referred to the region of the tumor. This is usually followed by the appearance of a bloody vaginal discharge small in amount bright in color, an elevation in pulse and temperature, a moderate leucocytosis and a drop in the sedimentation time. Abdominal palpation shows a sudden increase in the tension and tenderness over the tumor mass—the tumor itself increases in size.

Infected degeneration is most common during pregnancy especially in the mid trimester

while edema and necrosis with or without infection of the tumor are conditions which may be looked for during the puerperium. A degenerated subcervical fibroid may be sterile when it will cause few if any symptoms or it may become adherent to the intestine be infected and suppurate and simulate the picture of an acute abdomen with its abdominal pain, tension, distention, temperature, nausea, vomiting and leucocytosis.

The submucous or interstitial tumor may be partly or completely extruded into the cavity of the uterus during the puerperium. As a result of contraction and retraction this may lead to infection of the necrotic mass and produce a puerperal infection with foul lochia and endanger the woman's life from sepsis and continued hemorrhage. Myomas may make pregnancy pathologic by their influence on the symptoms of gestation for instance pain is often constant uterine contractions are not only increased but are made more painful or because of the situation of the myoma the uterus may be displaced and picked into the pelvis and occasion a train of pressure symptoms in the bladder, the rectum and in the pelvic veins and nerve extending down the

thighs and legs. Furthermore anomalous bleeding is not exceptional and when the tumor is large and rapidly growing symptoms of abdominal distention with digestive cardiac and pulmonary embarrassment may obtain.

Fibroids may have a marked influence on labor as there is usually a preponderance of abnormal presentations in pregnancy complicated by these growths. This we have seen predisposes to early rupture of the membranes, uterine inertia, prolonged labor, a high operative incidence, postpartum hemorrhage and an increased mortality to both mother and child. But this again is dependent not on the presence of the tumor but upon its location, size or the number of tumors and their relation to the contracting or dilating zone in the uterus.

Subserous tumors usually do not interfere with parturition unless they encroach upon the lower segment or are subserosal, intraligamentous or become twisted, adherent or impacted in the cul de sac. Impacted myomata are often so placed that uterine contractions cannot lift the tumor out of the pelvis. On the other hand tumors which during pregnancy seem impossible may be lifted out of the pelvis by uterine contraction and allow spontaneous labor to take place.

Growths that are firmly impacted in the pelvis displacing, distorting, blocking the cervical os may prevent any form of intravaginal delivery and when the constriction is unrecognized cause rupture of the uterus. Intra-vaginal delivery through a blocked pelvis always has had a high operative mortality for the mother. Pierson reports 30 pelvic tumors in 191 cases in which the fibroid was of sufficient size and in locations to cause anxiety to the attendant. Cragin and Ryder found 11 in 98 while we had 6 in 60. The respective operative incidence in these three series was 81.73 and 66 per cent.

Multiple myomata in the body of the uterus have a direct influence on the character and force of the uterine contractions. We have observed that women in the fourth decade of life who are subject to multiple uterine myomata frequently exhibit instances of primary inertia. This uterine inertia not only mani-

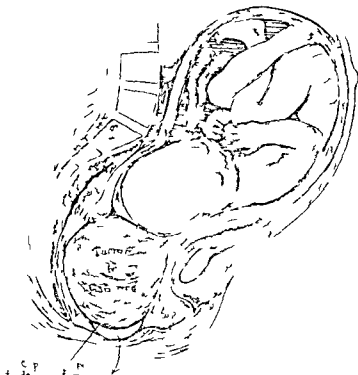


Fig. 1. Cervical myoma preceding the labor. Tumor 11 1/2 in. vaginal myomectomy followed by spontaneous delivery.

fests itself during the first and second stages of labor but continues into the third and becomes an important factor in the causation of postpartum hemorrhage. In Pierson's series hemorrhage occurred in 55 per cent in ours in 5 per cent.

The first stage of labor is usually delayed and prolonged; the contractions are irregular and ineffective though they are often more painful for much of the muscle area has been replaced by tumor masses and if the tumor is in the lower segment of the uterus and prevents a normal presentation with its ball valve action, early rupture of the membranes is the rule and will be found recorded in from 45 to 60 per cent of the cases. This of course, is an added factor in retarding the first stage. Likewise with the high incidence of malpositions and early rupture of the membranes it naturally follows that prolapse of the cord is more common owing to the fact that the presenting part fails to fill the dilating lower segment. However should the presenting part come into the pelvis and the tumor be displaced the second stage is not necessarily prolonged though it may be more painful. It is in the third stage in which fibroids often

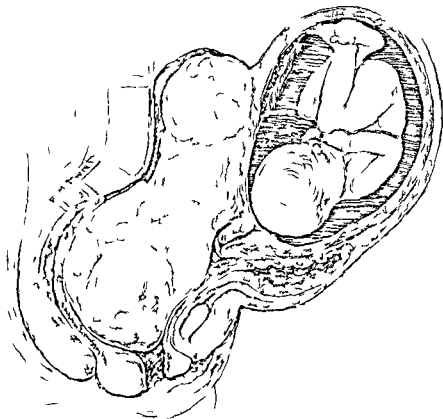


FIGURE 1. Uterus with fibroid tumor.

manifest their mechanical influence. The figure is normal in about 50 percent of the cases and the abnormality is manifested first by interference with the placental circulation and expulsion, second by postpartum hemorrhage, third by the occurrence of retained or adherent placenta and faulty drainage. All of these complications must be thought of in dealing with this phase of labor.

As a matter of clinical fact, while fibroids may produce all of the aforementioned complications, it is interesting to note that in large series of deliveries, relatively few actually require radical surgical intervention. In the Chicago Maternity in 13,000 deliveries, only 4 required abdominal section for dystocia, which was directly attributable to the presence of fibroid. At the Clinique Baudelocque in Paris, out of 14,000 deliveries, myomata of sufficient size to be considered of significance in the conduct of labor were found in 84, yet 66 of the cases went to term and had spontaneous deliveries. In Crigén's study of 5,000 cases at

the Skid Maternity, there were 84 which were completely unnoticed myomata, but only 11 had pelvic tumors, 9 of which required abdominal section or destructive operations for delivery. In Harn's recent review of 5,000 cases, there were 131 patients in whom the fibroid were of sufficient clinical importance to require painstaking observation. In this number there were 30 pelvic fibroids,

of which required some form of operative intervention to terminate the labor. In my personal series of 7,000 cases, there were 60 in which the position and size of the fibroid gave us anxiety during pregnancy and labor, yet there were but 6 tumors which required removal during pregnancy, and 4 which demanded section during labor to accomplish delivery. One pedunculated tumor of cervical origin was pushed out of the vulva in advance of the presenting part, enucleated by vaginal myomectomy and spontaneous delivery followed. Hence it will be seen that nature and retraction of the lower segment of the uterus

during labor are capable in most instances of taking care of the mechanical obstruction.

From the foregoing discussion it is shown that there is an incompatibility between pregnancy and fibroids. This is demonstrated by (1) the frequency of sterility (2) the tendency to abortion and premature labor (3) the stormy experience which some of the patients have in pregnancy and labor and (4) the degenerative changes which occur in these tumors in the puerperium.

MANAGEMENT

The question of the management of fibroid tumors in pregnancy resolves itself into determining (1) whether the life of the patient is endangered by allowing the growth to remain and (2) what effect its removal will have upon the continuation of pregnancy. Our experience shows that women with myomata of the uterus go through pregnancy and often repeated pregnancies with but little difficulty. Tumors that are apparently impacted in the pelvis are frequently lifted out spontaneously either in the course of pregnancy or labor. Therefore the necessity of emptying the uterus by therapeutic abortion when myomata complicate pregnancy very rarely occurs and hysterectomy with the non-viable child *in situ* is one of the rarest necessities in surgery. In the interest of the child interference should be delayed as long as possible. The policy should be intelligent expectant expectancy but we should always be ready to act. Therapeutic abortion has no place and is unsafe and unnecessary for not infrequently this is the only pregnancy which this woman may have and interference may damage the tumor tissues to such a degree that convalescence may be protracted and disturbed for the drainage in a fibroid uterus is poor and perforation of the tumor capsule may be the origin of infection. On the other hand spontaneous abortion apparently seems to obviate the dangers. The majority of cases will not require surgical interference unless the tumor by its location or degeneration seriously disturbs changes or endangers the health of the patient.

It has been our practice to delay any operation until after the viability of the child and

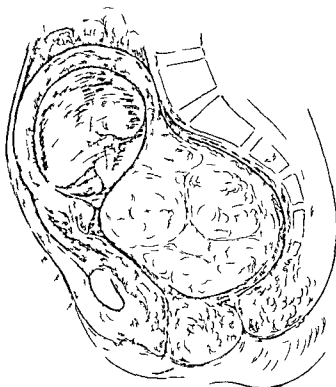


Fig. 1. Impacted tumor blocking delivery directly to the birth tract.

try to prevent abortion by instruction is to marital relations rest at the expected menstrual periods with the duly employment of the knee chest posture for by the use of this posture the tumor mass and uterus does not become impacted in the pelvis and the pelvic engorgement is relieved.

When the tumor is found in the pelvis in the early months of pregnancy we try to displace it with the patient in the knee chest posture. When this fails we continue the use of the knee chest posture preceded by a minute or two of the mule kick three times a day and wait to see what nature will do. The tumor is frequently carried up and out of the pelvis by the growth of the uterus or during the first stage of labor by the retraction of the lower segment. Only when the tumor has become (1) incarcerated and (2) when a pedunculated tumor becomes twisted or a (3) subserous growth enlarges so rapidly that it embarrasses the heart or respiration or the development of the pregnancy is any operation called for during the progress of the gestation.

Several experiences with operation for red degeneration has taught us that it is safer to allow the acute symptoms to subside and the

may or may not increase in size but conception does not occur. On the other hand the disappointment is all the greater when such a patient after years of sterility finally conceives and aborts early in spite of the greatest care to continue the pregnancy.

When pregnancy goes to term or near term in the fibroid uterus one need not be apprehensive except in rare cases in which the fibroid nodule is cervical or at least so low down it will not rise out of the pelvis as pregnancy advances. A pregnant uterus disturbed by many fibroid growths may usually do not give rise to trouble at the delivery while the cervical nodule by distorting the birth canal may make the labor extremely difficult. I recall a recent case seen in consultation in which the fetus died at the sixth month. The body of the fetus was expelled through the partially dilated cervix the head being left above the nodule. All efforts to remove the fetal head from below were unavailing and necessitated a hysterectomy in a puerperal patient. Fortunately the patient survived after a stormy convalescence but there might have been a different story. Looking back over such a history one would have performed the hysterectomy early in the

the diagnosis of fetal death was established. However on the whole more women and babies will be preserved by conservative treatment.

The danger of postpartum hemorrhage in full term labor in the presence of uterine fibroids is a real one. I have known of a number of instances in which the labor was perfectly normal yet the woman bled or almost died from imperfect uterine contraction. Uterine relaxation may occur even after the expulsion of the placenta and extra precaution should be taken to guard such a patient from postpartum hemorrhage. A number of years ago I had a good opportunity to observe the action of the uterine contraction of a fibroid uterus in which a cesarean was performed for another indication. One becomes so accustomed to seeing efficient uterine contractions occur after the uterus is emptied by cesarean that it is humiliating to say the least to be unable to cause the empty uterus to contract with the organ within one's hands but such was the case. All methods failed and I was compelled to remove the uterus to save the woman's life. It is most regrettable that we might be in certain cases when the manipulations are from below

CONCERNING THE PREVALENT DENIAL OF FUNCTIONS LONG
ATTRIBUTED TO THE GALL BLADDER.

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TWO radical conceptions of the gall bladder which have received considerable emphasis in recent years have had to do with negation of function. First the denial that the gall bladder plays any significant role in digestion (1). Some authors even going so far as to assert that no bile which enters the gall bladder ever leaves it by way of the cystic duct (2, 3, 4, 5) and second the contention that the gall bladder is a passive organ and that in case it is bile leaves the reservoir expelled by extrinsic forces for the direct receipt of which (6) will be not by the contractile force of the gall bladder musculature (7, 8, 9, 10, 11).

The first of the views is a tolerable one, and the second is fast succumbing to its rival. But unfortunately the criticisms have been more prevalent in recent years, so that we have seen wide prevalence in the utility of the gall bladder and the growing skepticism has resulted in the increasing resort clinically to unwarranted cholecystectomy so that it is no longer uncommon to find reputable surgeons removing normal gall bladders with normal appendices when operating for hypercetonemia or even in the course of exploratory laparotomy. As will be pointed out later the result of this procedure (in addition to disturbances of the biliary duct system which it creates) is to deprive the patient of that considerable supply of concentrated bile which regularly initiates the digestion of meat and fat entering the small intestine at the beginning of every meal.

CENTRAL OBJECTIONS TO THE THEORY OF A BILL RESERVOIR

Superficially viewed many facts have seemed to support the denial of active function of the intestine. It is generally agreed among surgeons that no one ever sees the

human gall bladder contract during an operation. But the reasons for this are sufficiently obvious. First there is no sustained stimulus for contraction, the stomach and duodenum being usually empty of food. Second it has been shown that mechanical manipulation, chilling, and deep ether anesthesia inhibit rhythmic contraction of the gall bladder (35). If however the abdomen is opened under local anesthesia (as recorded in 2 instances by Mitsujo) contraction of the human gall bladder may be observed 5 minutes after the administration of morphine sulphate. Also in the abdomen of cat opened under local anesthesia I have frequently watched contraction of the gall bladder lasting for several minutes after the intravenous injection of 0.005 milligram of adrenalin. This consists of a low puckering of the surface, a characteristic blebbing of the wall due to increasing density, and a gradual withdrawal of the whole vesicle from the margin of the foramen in which it lies.

It is true that fully contracted normal gill bladders are rarely if ever encountered in the operating room but this is a direct consequence of not feeding patients before operations. Previous to the introduction of antis the 11 however empty gill bladders were frequently observed at autopsy. I am Green knew that gill bladder were not of one size but found them in his dissection of animal

... sometime very full sometime empty and
sometime in an intermediate state (17)

A notable exception to this is the gall bladder of the hog which only partially empties after meals—usually not more than half its contents although on one occasion I was able to induce the evacuation of all but a cubic centimeter of its contents by a medical meal (Fig. 3). Unfortunately this peculiar feature, which has been well known for many years, other than that it enables the animal to store food in the stomach which Karl Carlson to conclude that the role of the gall bladder is the storage organ for the bile has been greatly exaggerated. This

$$W^M(h) = \frac{1}{2} h^2 \quad \text{if } h \leq 1 \quad \text{and} \quad W^M(h) = \frac{1}{2} \quad \text{if } h > 1$$

peculiarity of the canine gall bladder has never been explained but quite likely it is a consequence of its relatively larger size as compared with that of man the cat and the guinea pig—3 species in which it completely empties after a meal of egg yolk. According to Wakerlin the average volume of the bile reservoir of the dog is 15 cubic centimeter whereas in man it probably averages less than 45 cubic centimeter. In 4 patients whom I have visualized the estimated volume excluding the neck of the gall bladder averaged 30 cubic centimeter. The smallest one with which I have worked (Fig. 13) held 16 cubic centimeter and emptied nine tenths of its contents in 16 minutes after a meal of egg yolk and cream. In the next 50 minutes it partially filled and thereupon emptied again. Whether the third filling was followed by emptying could not be ascertained (Graph C p. 35, reference 8). It is not surprising therefore that complete evacuation of the gall bladder in dogs occurs only rarely. Nevertheless the mechanism is capable of greater range for it has recently shown that the gall bladder of the dog can be virtually emptied by repeated intravenous injections of a highly purified secretin (See supplementary note at end of article.)

Again the relatively small size of the gall bladder has been seized upon as evidence that this organ could not hold all the bile that is secreted in 4 hours and that it could not therefore function as a storage organ. But we now know that no such demands are made upon it for much of the bile secreted by the liver passes directly into the intestine more or less continuously for a time following meals and at longer intervals during fasting. (2) Within the last few years it has also been shown that the gall bladder has great concentrating power (3) and that frequently it discharges part of its contents during fasting (6) and all or much of its contents after meals (4).

Another argument that is often cited is the fact that the gall bladder may apparently be removed with impunity. Yet cholecystectomy frequently results in well recognized digestive disturbances (14) the first effect of extirpation being the dilatation of the extrahepatic ducts (4). Also change in pressure conditions after removal of the gall bladder is said to predispose patients to an earlier appearance of bile pigment in the blood should the common duct become occluded (8).

Finally congenital absence of a biliary reservoir in certain species of mammals has been cited as evidence that the human vesica

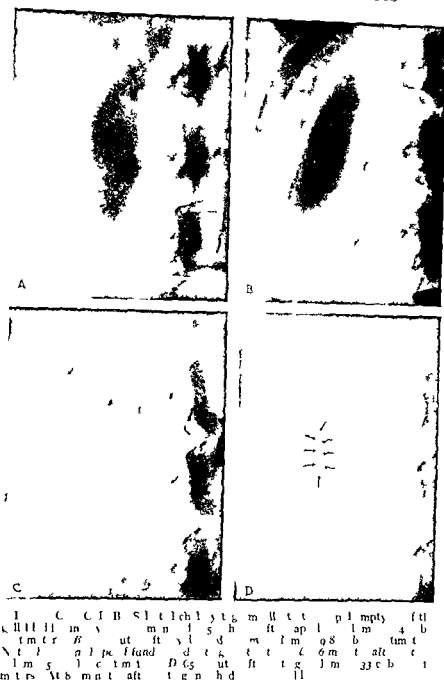
fella is useless notwithstanding the fact that no studies have ever been made upon the rate of flow of bile from the liver in such species. Yet it is conceivable that both the latent period of this flow and its rate differ from those in man and that these differences may be compensatory to the loss of a biliary reservoir. Furthermore it has been shown that the bilirubin concentration of the bile taken from the common hepatic duct of an animal which has no gall bladder—the rat—is 5 times as great as that from the hepatic ducts of one which has a concentrating organ—the mouse (6).

Another allusion to this may be added a hitherto unpublished observation of the writer. Last spring I had the good fortune to find a clear case of congenital absence of the gall bladder in an anesthetized cat with which I was working. After inserting a cannula in the common duct sufficient yellow hepatic bile was collected to permit a colorimeter test by clinicians of the Harvard Medical School to whom the sample was handed for analysis. When compared with a sample of yellow hepatic bile subsequently collected from the hepatic duct of a normal cat the bile from the animal without a gall bladder was found to be 4 times more concentrated than the bile drawn from the hepatic duct of a normal cat. If we may judge from one case it would thus appear that when the gall bladder is lost early enough in fetal life the deficiency is partly overcome by a compensatory mechanism.

All of which goes to prove the importance of a concentrating mechanism. Indeed it was the convincing demonstration of the concentrating function of the gall bladder by Kous and McMaster in 1911 which initiated a reluctant return to the historic conception of the gall bladder as an important organ of digestion. A second step in this direction was made when the sequence of events following the eating of a meal was set forth.

THE EMPTYING OF THE GALL BLADDER AFTER MEALS

Although it had long been recognized by physiologists (16) that ingestion of mixed foods is followed by the entrance of bladder bile into the duodenum it was not until 1913 that the matter was given an exact status by the discovery of a simple food (egg yolk and cream) which regularly and consistently empties the gall bladder of its fluid contents (3).



gall bladder which can be attributed to one source only the activity of the tunica muscularis. Beginning with Doyen graphic records of these contractions have been obtained by introducing balloons attached to various kind of manometers the gall bladder being either *in situ* or separated from the liver or even removed from the body. These studies have been supplemented by experiments testing the

action of drugs upon strips of gall bladder muscle isolated in physiological salt solution. In most of the cases in which it was observed *in situ* care was taken to prevent contact with adjacent viscera and to eliminate respiratory pressures. Using such methods in dogs Bainbridge and Dale (1) established the rate of contraction as 1 to 3 undulations per minute. Okada (31) found it to be from 2 to 5 per

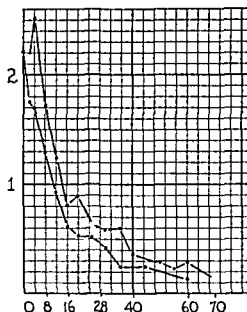


FIG. 3. Two contraction curves made from the same individual (Case N B B) illustrating the precision with which the human gall bladder responds to a meal of egg yolk and cream. The curve at the left was reconstructed from X rays made with the patient lying continuously upon a table. The one at the right was made 2 months later with the table rotated to a vertical plane and with the patient continuously in an upright position. For original X rays see Figure 7. In other respects the conditions were constant. Apparently gravity does not affect the rate of emptying. Incidentally this series represents the fastest emptying time recorded in any young man. Ordinates represent cubic inches of bile above a time in minutes after a meal of 5 egg yolks and a half pint of cream periods (in contraction curve) successive X rays. For data on rate of emptying of stomach and intestine in this individual see Figure 1 (N B B) bibliography.

minute but noted that the rhythmic activity was much more marked following a meal of horse meat. In the most recent study that of Taylor and Wilson (35) the rate was placed at from 2 to 6 contractions a minute i.e. somewhat faster than that of the stomach. These authors brought out the further interesting facts that the gall bladder rhythm was very sensitive to such conditions as chilling, anaesthesia and manipulation of either the organ itself or the duodenum but that intravenous injections of adrenalin greatly increased the amplitude of the contractions. This latter observation is very significant and is in accord with the writer's discovery that intravenous injection of adrenalin causes more pronounced momentary expulsion of iodized oil from the gall bladder than that of any other drug—the contraction being visible to the naked eye in animals with the body cavity opened under local anaesthesia.

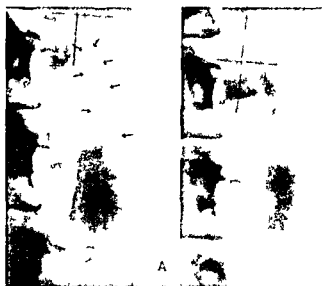
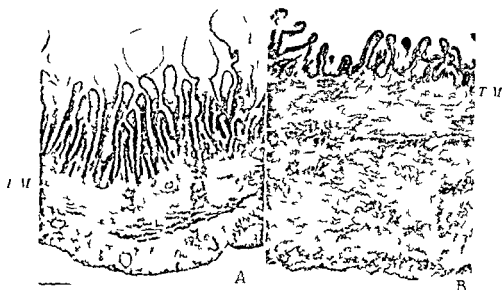


FIG. 4. Selected cholecystograms of a young woman (Case N B B) showing change in shape of gall bladder after a meal of egg yolk and cream. Left: X rayed in upright position continuously for several hours after eating. 12 minutes after eating, volume 36 cubic centimeters. Note sagging shape and irregular concentration of dye in body and fundus. Right: 15 minutes later, volume 16.5 cubic centimeters. Note more uniform density and shape of gall bladder at 15 minutes after eating. Also note the rapid rate at which it empties against gravity.

3. *Changes in shape following meals.* A third line of evidence is the change in shape which the gall bladder undergoes following meals—a change which can be interpreted as due only to contraction. This has been demonstrated both in the human body and in animals. In X rays of the human gall bladder the first significant change usually appears in the fundus (Figs. 2 and 4; see also earlier papers 5). Previous to a meal the pear-shaped sack appears relaxed as if sagging under the weight of the iodized bile. But often within 2 minutes after a meal the fundus narrows as if the bile were being lifted by compression from the bottom. Sometimes this is sufficient to reverse the shape of the organ—the fundus becoming narrower than the body.

The writer cannot advocate strongly enough the importance of X raying patients after meals as well as before as a routine procedure in roentgenological departments. The simplest method would be to have pictures made every 5 minutes during the first half hour after the patient drinks a pint of milk. This diet would not completely empty the gall bladder but would cause the first and most important phase of contraction when the gall bladder delivers over half of its contents (6). There are several reasons for adopting this procedure: first to test the



The gall bladder is a pear-shaped sac-like structure, usually about 10 cm. in length and 3-4 cm. in width. It is situated in the right upper quadrant of the abdomen, beneath the liver. The gall bladder is composed of an outer layer of serosa, a middle layer of smooth muscle, and an inner layer of mucosa. The mucosa is folded into numerous longitudinal ridges called rugae. The gall bladder is connected to the liver by the hepatic ducts, which join to form the common bile duct. The gall bladder is also connected to the duodenum by the cystic duct.

centers a rate of contraction for the purpose of increasing the normal height of the gall bladder wall. This is a mechanical process. In normal conditions, the gall bladder contracts during fasting and relaxes during feeding. The contraction of the gall bladder is controlled by the vagus nerve and the sympathetic nervous system. The gall bladder is also capable of storing bile and concentrating it.

In animal, the contraction of the gall bladder has been studied by a variety of methods. Whitaker, working with cats and employing the cannulized oil method, has published X-rays which show contractions in the neck, body, and fundus of the gall bladder following a meal of egg yolk (Fig. 5 and 9). He also observed the changes taking place under the fluoroscope (30). Higgins and Mann, having opened the body cavity of the guinea pig under local anesthetic, observed the gall bladder for several hours as it diminished in volume after a meal of egg yolk. They noted that at first there were several centers of contraction which induced a variety of patterns but that later these independent areas gradually merged to effect the reduction of the whole organ (21). Subsequently they found

that stimulation with an induction current produced marked contraction of the gall bladder (2).

4. *Critical experiments.* Actual expulsion of the content of the gall bladder in response to smooth muscle drugs, adrenalin and food have been recorded under experimental conditions which rule out the action of extrinsic forces. McManis and Elman (27), for instance, excluded the factors by means of an ingenious system of triple intubation: separate tubes being intubated in one animal—the first in the cystic duct, the second in the upper part of the common duct, and the third in the lower part of the choledochus. After feeding the animal they were thus able to record simultaneously the flow of bile from the gall bladder into a manometer, the amount of bile secreted by the liver, and the resistance to the passage of bile offered by the intestinal wall. An important feature of their work was the fact that the tubes were intubated at least 10 days before the experiment, the tubes being so connected during this interval that no disturbance of function resulted from the operation. The dogs were then trained to co-

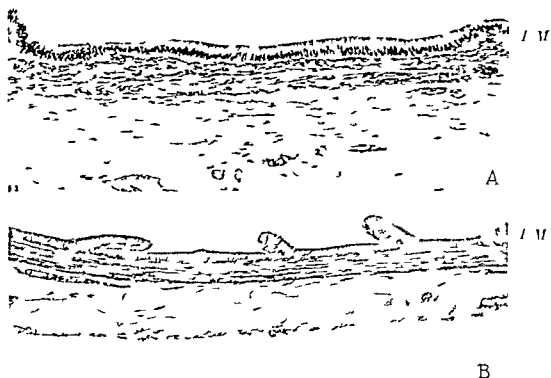
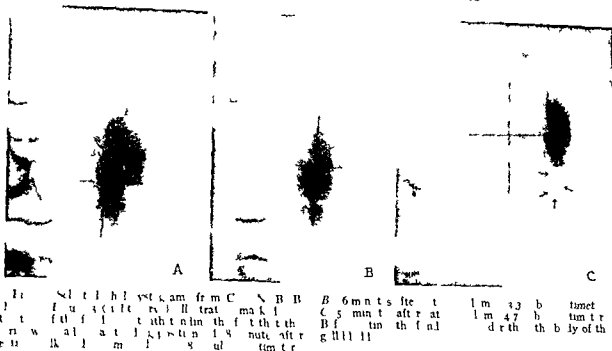


Fig 6 Photomicrographs illustrating thickness of muscle layer *T M* in fully distended gall bladders. *A* from a 9 months old child (by courtesy of Dr Halpert) *B* from an adult cat (*A* and *B* same magnification)

operate and were in normal condition at the time of the experiment. Under such favorable conditions these investigators were able to demonstrate the sequence of events following the ingestion of food. They found that immediately after eating there was an abrupt increase in pressure within the gall bladder (100 to 125 millimeters of bile) and simultaneously a relaxation at the duodenal orifice of the common duct. In an accessory experiment on the same animal they measured the amount of bile emerging from the intubated gall bladder instead of recording the pressure changes by a manometer. In contrast to the abrupt emergence of bile from the gall bladder there was no immediate increase in the flow of bile from the liver and when it did begin it was gradual. Since Kelling had shown that 300 grams of food could be eaten by a dog without increasing the intra-abdominal pressure owing to a compensatory relaxation of the abdominal muscles intra-abdominal pressure was not a factor in the expulsion

of bile from the gall bladder. Nor could it be attributed to the flushing action of hepatic bile nor to the sucking action of peristalsis since the manometer tube was connected to the cystic duct only. The conditions of the experiment therefore permit but one conclusion namely that the bile was expelled from the gall bladder by the action of its muscular tunic in response to the ingestion of food.

Balloon experiments with the gall bladder of the dog have been a favorite pastime of physiologists and surgeons up to the present writing. Many who have restricted their observations to manometer readings have inferred that the pressure changes induced by the admitted contraction of the gall bladder around the balloon were not sufficiently great to expel the bile. But they have not taken into consideration the damaging effect of all forms of general anesthesia upon gall bladder action nor the quantitative difference which quite likely distinguishes the contraction in the dog from other species such as man in which the whole viscus has been known to empty in 15 minutes (Fig 1). In the opinion of the writer the work of McMaster and



Human on lg tanl ut alive ll others in the ingenuity f the experim t in the up r r t y of th c n l t n under hich th lg ere te tel an l n the fact that they of se f the act n l e pul n of bile n l r h e l n t m e r e l y upon pre ure change

Similar conclusions were reached by Higgins and Mann (21) in a careful investigation employing somewhat different methods. Having trained dogs to lie on the operating table quietly for several hour they opened the abdominal cavity under local ana the n and observed the emptying of the gall bladder under conditions in which every factor but the action of the muscle tunic had been excluded. The sucking action of peristalsis was eliminated by inserting a rubber catheter into the common bile duct so that bile flowed into a manometer and not into the duodenum. Any flushing of the gall bladder passages by the liver bile was prevented by tying all the hepatic ducts.

Higgins and Mann also disproved the efficiency of respiratory pressures by ingeniously demonstrating the emptying of the gall bladder in vertebrates which breathe by gills and not by the rhythmic action of the diaphragm. In order to work with the gar pike an ancient armored fish of the Mississippi Basin they fed these animals with egg yolk kept them

quiet and at necropsy found the gall bladder collapsed. Obviously the gall bladder of the fishes were not emptied by external pressures. To these same authors also belongs the credit of establishing the contractility of the gall bladder in the guinea pig (see recent summary of the physiology of the extrahepatic biliary system in this animal 23).

About the same time that these two groups of investigators were reaching independent but similar conclusions about the emptying of the gall bladder in dog and guinea pigs Whitaker (26) and the writer (5) were accumulating data which seemed to show that the gall bladder of cats also emptied by virtue of the contractile force of its muscular tunic. For it was found that marked expulsion of iodized oil could be induced by the intravenous injection of smooth muscle drugs. In addition Whitaker showed that a barium meal mixed with egg yolk could be moved through the whole intestinal tract by peristalsis without causing the discharge of a single drop of bile from the gall bladder (series 31c)—a circumstance which could not have occurred if Burget's theory of the sucking action of peristalsis (10) had been correct. Recently the writer has confirmed this on a human case. On the positive side Whitaker showed that

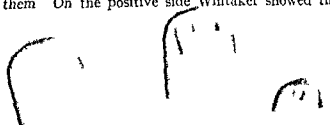




Fig 8 X rays of an experimental animal (Cat 1) in which the gall bladder was filled with iodized oil and the bile duct covered so that iodized oil was leaking out into the body cavity at the time the abdominal wall was sutured. *A* 2 hours after the operation. Note iodized oil in the body

cavity. *B* 4½ hours after operation. Gall bladder not yet emptied notwithstanding the fact that the bile duct has been severed. *C* 1½ minutes after meal of egg yolk. Note bile in cystic duct.



Fig 9 Experiment similar to that shown in Figure 8 except, that a funnel was placed in the covered end of the common duct to insure free exit of bile into the body cavity (Cat 1). *A* One half hour after operation. *B* 3¼ hours after operation. Iodized oil stuck in the common duct is the same as that seen in 1. Gall bladder has

emptied little if any during this time. *C* 40 minutes after egg yolk. Note contraction in the fundus of the gall bladder and continuous column of oil from the fundus to the end of the common duct showing, in response to food in spite of the fact that the connection of the gall bladder with the duodenum has been interrupted (cf figures reference 9).

when the wall of the gall bladder was damaged by squeezing it with clamps the viscus failed to empty in proportion to the amount of injury. Obviously the action of intra abdominal pressure upon the gall bladder would not have been interfered with by this procedure. And within a few months Spurling and Whitaker (33) have shown that patients who were subjected to operations for drainage of the gall bladder (merely cholecystostomy) never recovered the ability to empty the gall bladder—the inference being that the muscle tonic was permanently impaired.

Continuing the work on cats the author sought to eliminate by two methods every factor but that of the gall bladder muscula-

ture. The first of these (5) consisted in filling the gall bladder with iodized oil and then tying the common duct just below the entrance of the cystic duct. Since several hepatic ducts opened below the point of ligation the animals did not become jaundiced. But tying the duct eliminated the effect of intestinal peristalsis and sphincter action. Also since no bile could escape from the gall bladder into the intestine many experiments could be tried on the same animal (starting with the gall bladder in the same state of distention) thus permitting a comparative study of different reagents. The day after the operation when the cats were in good condition purring and moving about the gall bladder was X rayed.



special form of stimulation was required. When that was applied the gall bladder responded (Figs. 8 and 9).

The suggestion may be advanced by those who are familiar with the recent work of Luetkens (5) that the failure of the gall bladder to empty in the animals after the duct is severed is due to a spastic contraction of the neck of the organ induced by operative shock. This presupposes a special thickening of the circular muscle to form the so-called "cylindrical sphincter." But longitudinal sections of the cut gall bladder muscle with this preparation show no increase of thickness in the circular muscle of this region. M. O. Halpert (11) remarks that the same is true of the human gall bladder and that if a thing the muscle of this region is thin.

The writer has placed considerable emphasis on this capacity of the gall bladder to respond to food stimulation when its connection with the duodenum has been severed on account of the persistent effort of certain investigators to explain the discharge of bladder bile as due primarily to the opening of the sphincter at the outlet of the common bile duct or to the mechanical action of intestinal peristalsis. Burget (11) has even attributed the emptying of the gall bladder to lowered tonus of the duodenum caused by the presence of fat in that portion of the intestine. Yet having thereby called attention to the lessened effectiveness of the intestinal muscle after a fat meal he nevertheless returns intestinal peristalsis as the chief evacuating mechanism of the gall bladder. Equally illogically those who have sought to minimize the action of the gall bladder musculature have been most insistent in denying the existence of a sphincter at the end of the common duct. If both of the contentions were true the remarkable precision with which the human gall bladder responds to the ingestion of food (Fig. 1) would be utterly inexplicable. Fortunately it is not necessary to accept either hypothesis. Within a few months Mann and Higgins (9) have demonstrated a sphincter action of that portion of the common duct in the dog which lies some distance behind the papilla thereby nullifying the conclusions of those investigators who have sought to establish the fact that the filling and emptying of the gall bladder were controlled by the intestinal mus-

No change in shape occurred before the experimentation showing that intra-abdominal or respiratory pressure or distention in the gall bladder were unable to cause the column of heavy iodized oil. But as soon as food was given the gall bladder elongated and turning the column of heavy oil for 4 hours. It was also found that kin irritation (such as was induced by shaving the animal legs) or protein shock (caused by blood transfusion) also produced a temporary elongation and intravenous injection of smooth muscle drug and adrenalin the latter causing marked expulsion of the oil into the cystic duct against the secretory pressure of the liver.

In a recent series of experiments the same results were sought by another method. At the time that the gall bladder of the cat was filled with iodized oil the common duct was either severed or slit open or a cannula introduced so that the contents of the gall bladder could empty freely into the peritoneal cavity. By thus interrupting the common duct any possible pumping action of intestinal peristalsis was prevented. In each case before the body cavity was closed up it was determined that bile and iodized oil (which had just been injected into the fundus of the gall bladder) were leaking out of the incision in the common duct. But in no instance did the gall bladder empty the day of the operation as would have been the case if elastic tissue or intra-abdominal pressure or the stimulating action of the hepatic bile had been effective. Each time some

culature after the sphincter papillæ had been removed

In conclusion therefore it seems reasonable to assume that in the cat dog guinea pig and man bile is expelled primarily by the contractile force of the muscle tunic of the gall bladder. With this fact assured the immediate problem of the future is to find that mechanism by means of which the gall bladder musculature itself is activated and how the flow of bile from the common duct is regulated.

SUPPLEMENTARY NOTE—Since this article was submitted several important contributions to the subject have appeared in the literature. Chief among these is the convincing demonstration by Ivy (Proc Soc Exp Biol & Med 1923 xx Nov) that evacuation of the gall bladder in the dog may be secured by intra-cous injection of a highly purified secretin. This seems to establish the fact that after food contraction of the gall bladder is maintained by a humoral mechanism originating in the mucosa of the small intestine.

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Fig. 1. X-ray of Case 2 showing left catheter in renal pelvis and right catheter obstructed at sacroiliac synchondrosis. No shadow seen which would suggest a calculus.

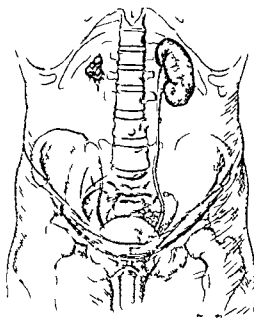


Fig. 2. Schematic drawing showing nodules of rudimentary renal tissue in right kidney region of Case 2. Nodules connected by fibrous band. Lower portion of ureter pertinent to sacroiliac synchondrosis. Upper portion not found at operation.

under the stress of carrying on all the excretory function the solitary kidney becomes damaged whether by nephritis, calculus or infection. Ballowitz stresses the frequency of calculus formation in the solitary kidney while the combined statistics of Ballowitz, Moore and Anders indicate that a greater than the normal percentage among subjects of congenital single kidney die of kidney complaints. Anders also found that in 4 per cent of the cases in his series the single kidney showed advanced lesions of chronic nephritis.

Throughout this discussion we have used the term aplasia to mean incomplete development. This we believe would also include both the absent and the rudimentary kidney. The differentiation being only a matter of degree.

The cases we have to report are as follows:

CASE 1. Mrs. P. L., age 19. Case No. 5914. She was admitted to the hospital July 16, 1916, suffering from pain in the right lumbar region of 4 days duration. The attack had commenced with aching pain in the right lower quadrant of the abdomen followed shortly by similar pain in the right lumbar region

and more acute attacks radiating down the right leg. The following day the patient developed fever and chill and a frequency by day every half hour voiding small quantities and with marked burning of urination. She gave a history of right sided pain with fever and chills during her first pregnancy 3 years previously but had no such symptoms during the second. She was admitted to the hospital on the day following the onset of her symptoms and on examination appeared to be in marked pain with frequent rigors and a temperature of 103 degrees. There was marked tenderness in the right costo-lumbar angle also over the whole right side of the abdomen. The right kidney was easily palpable, enlarged, firm and tender. The left kidney was not palpable nor tender. There was no abnormality of the external genitalia. The urine was cloudy, straw-colored, 1010 specific gravity and acid in reaction, albumin+, sugar 0. Microscopically there were present epithelial cells, motile bacilli, pus++ but no red blood cells or casts.

One cubic centimeter of phenol-ulphe-nephthalein intramuscularly gave first hour 10 per cent, second hour 25 per cent, total 35 per cent.

On cystoscopy the bladder mucosa was found to be slightly inflamed. The right ureteral orifice was normal in position and appearance but the left was not made out. The right ureter was catheterized to the renal pelvis and a specimen was obtained which showed microscopically epithelial cells, pus++.

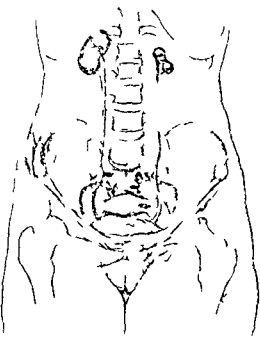


Fig. 5. Schematic drawing showing two cysts connected by fibrous band in Case 3. Lower portion of ureter patent upper portion absent.

and prostate were normal. His urine was clear straw colored specific gravity 1020 and some albumin was present but no sugar. Microscopically there was pus bacilli motile epithelium and calcium oxalate crystals.

His renal function by the phthalate test intramuscularly given was apparently normal first hour 55 per cent second hour 15 per cent total 70 per cent. Blood Wassermann was negative. No tubercle bacilli were demonstrated in the bladder urine on several examinations.

X-ray of the kidney and bladder region showed a small round shadow opposite the fifth lumbar vertebra on the right side.

At cystoscopy the bladder mucosa was found to be slightly inflamed. The ureteral orifices in normal position appeared slightly gaping. The left ureter was catheterized to renal pelvis and a specimen was obtained. The right ureter could be catheterized for only half the distance and no specimen was obtained. The specimen from the left kidney showed an occasional red and white blood cell and a few epithelial cells and culture gave a growth of bacillus coli communis. X-ray with catheters in position showed the left catheter up in the renal pelvis but the right only at the sacro iliac synchondrosis. No shadows were seen suggestive of calculus or of the previously noted shadow. A second cystoscopy confirmed these findings also and cocarmin injected intravenously appeared from the left side in 5 minutes but none from the right side in 15 minutes (Fig. 1).



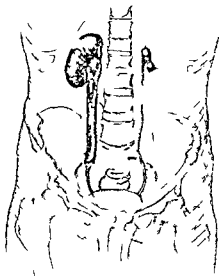
Fig. 6. Photomicrograph of section from cyst wall in Case 3. Connective tissue predominant with fibers and there are tubercles of partially and completely developed tubercles. Some of the tubercles contain cysts. Low power.

The diagnosis was made of a probable closed tuberculous lesion of the right kidney and operation was performed on August 6, 1935. On exposing the right kidney only a small mass of fat and fibrous tissue was found containing several small nodules of a firmer tissue. Attached to these were several small blood vessels. No ureter could be found. The mass of tissue was removed from a small indefinite pedicle. There was no other evidence of kidney tissue (Fig. 2).

Report of examination by Dr. Waugh of the Pathological Department was as follows: Specimen consists of a mass of reddish tissue of rubbery consistency about 30 grams in weight. At one end is a cyst with a smooth pale wall. It is the size of a small walnut.

Sections of the tissue show it to be made up of an irregular mass of loosely arranged fibrous connective tissue containing numerous larger and smaller blood vessels. There are occasional peculiar duct-like structures containing blue staining, more or less homogenous material and lined by small irregular cells having little resemblance to epithelium but probably being atrophic degenerated and necrotic undifferentiated lining.

The cyst wall consists of a wavy fibrous connective tissue without epithelial lining. Hyaline fusion of the fibrous connective tissue is occasionally seen. There



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Diagnosis: Influenza (Fig. 3)

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The urine of a healthy strain of guinea pigs showed a negative reaction with albumin, sugar, epithelial cells, a few white blood cells and a few motile bacilli. No tubercle bacilli were found in

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Fig. 9 Section of nodule in Case 4 showing a matrix of connective tissue with flattened epithelium. Several glomeruli present overgrown by fibrous tissue. Low power.



Fig. 10 Photomicrograph from aplastic kidney in Case 5 showing glomerulus and one tubule enclosed in connective tissue. Glomerulus has been invaded with connective tissue which has undergone hyaline degeneration. Lumen of tubule contains an albuminous cast. High power.

On opening the left loin we saw a small mass of tissue in the kidney bed. This consisted of several rounded cyst-like bodies, one the size of a plum, the other much smaller. No ureter could be made out. The pedicle consisting of several small vessels was ligated and the mass removed. The two cystic masses were connected by fibrous tissue bands (Fig. 5).

Incision of the cysts revealed a more or less viscous fluid, dark amber in color, about 15 cubic centimeters from the larger and 5 cubic centimeters from the smaller. This fluid showed on examination to have approximately the same findings for urea, etc., as for blood. Urea, 360 gms. per liter of fluid; urea nitrogen, 16.80 milligrams per 100 cubic centimeters of fluid; creatinin, 1.59 milligrams per 100 cubic centimeters of fluid; sugar, .093 per cent.

Examination of the tissue removed showed an irregular dense fibrous tissue with areas of hyaline fusion, containing nests of poorly developed tubules, the lining epithelium of which is swollen, so that its differentiation is lost. The lumina are filled with hyaline casts.

Glomeruli are rare and the capillaries in Bowman's capsule are disintegrating. Sections of the cyst wall show it to consist of a thin capsule of fibrous connective tissue having an inner margin of flattened epithelial cells (Fig. 6).

Diagnosis: aplasia of kidney with multiple cyst formation of rudimentary tubules.

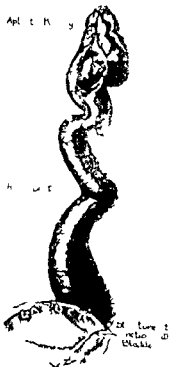
Patient has much improved, has gained 40 pounds in weight and has been free from symptoms since operation.

CASE 4. Mr. D. St. G., age 30, was admitted to the hospital on May 27, 1926, complaining of anuria of 4 days' duration. He had been suffering from slight attacks of pain in both loins for the previous years. These attacks were accompanied by some burning urination. He had a slight attack of pain in the right loin radiating down to the groin shortly before the onset of the anuria. The history apart from this was negative.

On admission the patient appeared in evident distress, though there was no vomiting or nausea and no edema of face, hands or feet and mentally he was quite clear. The tongue was coated and dry. The eye grounds were normal. General examination was negative.

Blood pressure 110/75.

Examination of the genito-urinary system revealed no costal-tubular tenderness. The kidneys were not palpable, though there was slight tenderness in the left loin on bimanual palpation of that side. No masses were palpable in the loins. There was no tenderness along the course of either ureter and no suprapubic distention. The penis was normal in



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o i l n i v a s t p l l h e l l l l l r s v m
m e t r i d t h m u a n e m a l t h u r e t r a l o r i c e
n o r m a l u r t r i n f i s t i o n The r i g h t u r e t r
v a c t h r l f r a h t n e o f l o u t 4 c e n t i
m e t e r s h e n l i n t l t r u c t u r s m e t t h e l e f t
u r e t e r a t h t e t a c t o r a b o u t 25 c e n t i m e t e r
w h e n l e i n t l t r i t i o n w a s m e t N o s p e c i
m e n o f u r i n e w e r e b r a i n l N e x s t a k e n w i t h
c a t h e t e r s p i t i n l o c a l i t h i n t h e r l a t e
p i t i n m e n t i n e l l u t n h r d o v s w e r e s e e n
s u g g e s t i v e o f c a l c u l i N o c l e a r l y d e f i n e d k i d n e y
h a l s e e n The c y s t c o p y s i s r e p r e s e n t e d
t h e f l l i n g h a l u t w i t h t h e s a m e n e g a t i v e r e s u l t s
(I₁₆)

I s l l t m e s t a p h o f c t a f t a f o r p l
t a k f v n f l l g t h h y a l r m s f g
m r u l t h f l l t l t u l c e n t e a t T h e
J g l f o u f e f l l i f t r a t n o f t h n e t e t

(On the morning of May 31 he had still not voided an urine and it was seen that his condition was critical. He had become nauseated and was vomiting all fluid taken. He had become edematous and was also somewhat cyanotic and dyspnoeic. An operation was indicated as the last possible means of relief as he had not voided for days.)

In view of the history of pain on both sides and the high tension noted on the left side at examination that side was opened first. His blood urea at this time had risen to blood urea 6.6 grams per liter of blood blood urea nitrogen .0708 milligram per 100 cubic centimeters of blood.

The opening of the left loin revealed the testes marked by ligamentous. No perirenal capsule was found and no kidney. In the region where the kidney lay there was a small mass of fat and fibrinous tissue containing several rounded masses of firm tissue. Several small vessels entered this firm mass, a pedicle from the mass was also a fibrous cord running to the bladder. This mass was often removed (Fig. 8).

The right loin was then opened and a slightly larger than normal kidney found. The surface appeared slightly granular and was drier than usual even. The pelvis and ureter were markedly dilated and the wall of the ureter much thinned out. An opening was made at the ureterovesical junction and a large quantity of clear pale urine escaped. A bougie was then passed down and mud mixed with

obstruction in the pelvic portion of the ureter. This was overcome and a No. 1 bougie was passed to the bladder. A tube was then inserted in the opening in the pelvis for drainage.

His condition improved immediately upon the establishment of drainage. A large quantity of urine drained from the loin for weeks when after the right ureter was dilated to No. 9 the patient voided and several days later the wound became dry. The urine passed was pale and of a low specific gravity 1008.10. There was some slight infection with colon bacilli following the operation. The small specimen removed from the right side was examined by Dr. T. R. Waugh of the Pathological Laboratory and his report is as follows:

Specimen consists of some fat tissue in which are a few fibrotic masses of firmer tissue. Section shows irregular masses of fat cells connected by a loose fibrous stroma. In some areas are irregular tubular spaces lined by a regular layer of cuboidal epithelial cells. These large pale cells appear of the embryonic type. The arrangement resembles the anlage of convoluted renal tubules. There are also tufts of cells resembling glomeruli containing red blood cells. There is a dense fibrous tissue stroma surrounding these structures and numerous thick-walled vessels are seen. There is no related definite kidney parenchyma although metanephrotic blastoma with tubular and glomerular formations are found (Fig. 9).

Diagnosis: aplastic kidney, congenital malformation of metanephros.

Patient was seen again in October 1906 when he had gained in weight and strength. He was free from symptoms but his urine was still of low specific gravity and there were scattered pus cells and colon bacilli in the urine. Blood urea .75 grams per liter of blood, blood urea nitrogen .35, 35 milligrams per 100 cubic centimeters of blood.

When he was seen again in January 1907 his urine still contained scattered pus and was of low specific gravity. The phenolsulphonphthalein output was 20 per cent for 2 hours. Blood urea .660 grams per liter of blood, blood urea nitrogen .30, 30 milligrams per 100 cubic centimeters of blood.

The right ureter easily admitted a No. 6 catheter and there was no hydronephrosis.

CASE 5. Mrs. I. M., age 40, was admitted to the hospital first in 1914 suffering from incontinence of urine following a birth trauma which had occurred in 1913. She had complete incontinence of urine. Her general examination was negative; the blood pressure was 146/88.

Cystoscopy showed a small bladder containing about 1 ounce of thick creamy pus. The mucosa was inflamed. There was a large opening toward the right side on the floor communicating with the vagina.

The left ureteral orifice was normal. This was catheterized and normal urine was obtained. No right ureteral orifice could be demonstrated and indigocarmine injected intravenously appeared from

the left ureter but not from the right side nor from any portion of the right side of the bladder. A plastic operation was performed. This was successful for some months but incontinence reappeared.

It was found on the next admission that a small fistula from the bladder communicated with the cervix and a hysterectomy was performed. Examination of the urine from the left kidney showed at this time some evidence of infection. She was admitted to the hospital in 1908 suffering from fever, chills, and pain on the left side and also incontinence of urine. A small vesicovaginal fistula was present.

Cystoscopy and catheterization of the left ureter showed an infected hydronephrosis. A ray with the catheter in place showed a marked kink in the lower left ureter with the catheter coiled downward toward the iliac crest, evidently a stricture which has resulted from trauma at the time of the hysterectomy.

She again entered the hospital in 1903 in uremia and died shortly after admission.

Examination showed a large distended pyonephrotic sac on the left side with the lower portion of the ureter narrowed and bound down in a mass of scar tissue. Examination of the right kidney showed a small mass of kidney tissue about the size of an almond covered with a thick fibrous capsule. The pelvis was small but the ureter appeared about the normal size. About 3 or 4 centimeters from the bladder it was completely stenosed and became lost in a mass of scar tissue about the bladder. Microscopically the kidney appeared to be made up of a mass of fibrous tissue with a few small blood vessels showing hyaline degeneration of their walls. An occasional tubule with flattened epithelial lining and a few glomeruli which had undergone invasion by fibrous tissue were seen scattered throughout the fibrous tissue of which this was mainly composed (Fig. 10).

CASE 6. L. M., boy, age 9 years, was admitted to hospital May 1914 complaining of frequency of day of five to six times and cloudy urine which had been noted by parents for the past 3 years. He had also suffered from enuresis since childhood. On examination he appeared to be well developed and nothing abnormal was noted. His blood pressure was 100/65. The genito-urinary system on examination showed no costal-umbilical tenderness; the kidneys were not palpable. There was no ureteral tenderness and no tenderness nor distention of the bladder. His urine was cloudy amber, specific gravity 1000, acid, albumin +, no sugar. Microscopically it showed pus, a few red blood cells, and a few cocci. No tubercle bacilli were found in the bladder urine. The phenolphthalein test: 1 cubic centimeter given intramuscularly showed in 1 hour 30 per cent, second hour 100 per cent, total 5 per cent. X-ray of the kidney and bladder region did not show any shadow suggestive of calculus. Cystoscopy showed a rather tight anterior urethra. No. 18 cystoscope being used. The bladder was symmetrical; the mucosa was slightly inflamed. The right ureteral orifice

was normal. The left ureteral orifice was scarred and gaping. The left ureter could not be catheterized. Normal urine was obtained from the right side (Fig. 11).

From the age of the boy and the frequency and condition of the ureteral orifice a diagnosis of probable tuberculous lesion was made and operation performed. At operation the left kidney was found to be small, scarred with a slightly thickened renal pelvis and a markedly dilated and tortuous ureter filled with purulent material and adherent to the surrounding tissues. The kidney and ureter were removed with difficulty. The kidneys were a thin red outfilious sac surmounting the white pelvis and ureter. Microscopicall it showed a thin wall made up of fibrous connective tissue and small blood vessels in the hyaline remnant of many glomeruli. A few tubules were also noted (Fig. 12).

The patient made an uneventful recovery. He has since gained in weight and apart from one attack of hematuria 6 months later from the ulceration of the left ureteral orifice has been free from symptoms.

An analysis of these six cases might prove of interest. From the point of view of sex the numbers are equal there being three of each. The ages are 9, 19, 31, 31, 35, and 40 years.

The left kidney was involved in 4 out of the 6 cases and the right in 2. This agrees with the majority of cases reported. Out of a short series of 15 cases collected by Goldstein the left side was involved in 13, the right in 5 cases.

The symptom which compelled these patients to seek advice were usually on the side of the remaining kidney although three of the children denoted pain on the side of the aplastic kidney and in Case 5 the pain was confined solely to that side. The frequency, burning, and pyuria were in all but one case due to infection of the solitary kidney.

In Case 6 the symptoms were evidently due to infection of the large distended ureter on the side of the aplasia.

In Case 1 the solitary kidney was the seat of an acute pyelonephritis and there was a history of an attack of pyelitis 3 years previously during pregnancy. The kidney in this case was about twice normal size as shown by X-ray examination and at operation.

In Case 2 the remaining kidney was the seat of a low grade chronic pyelitis as shown by a few white cells at cystoscopy and a positive culture of bacillus coli communis. No enlargement of this kidney was shown by X-ray examination.

In Case 3 the patient had suffered from attacks by pyelitis on several occasions. The kidney shadow was not shown to be enlarged by X-ray examination.

In Case 4 there was a period of anuria of 14 days and at operation a slightly enlarged kidney with a dilated pelvis and ureter were found. There was a stricture of the ureter present in its lower third. A similar case was reported by Eisendrath several years ago.

In Case 5 the renal aplasia was considered during the examination for the relief of a vaginal fistula and verified at autopsy. The remaining kidney was the seat of infection and following the trauma to the ureter and the resulting stricture a large pyonephrosis developed.

In Case 6 the remaining kidney appeared normal in size and function.

There were no associated genital abnormalities in any of these cases.

The bladder was symmetrical in 5 cases. Case 1 showed an absence of the left ureteral orifice and the left half of the trigonal ridge.

The bladder was inflamed in 4 of the 6 cases which could be explained by the acute infection above.

The right ureteral orifice was not seen in Case 5. Whether this was damaged at the time the vaginal anal fistula was incurred is a question. A stricture of the lower ureter was present in that case and the terminal inch or so was lost in a mass of scar tissue.

The ureteral orifices in the remaining cases were in the normal situation.

In Case 6 the left orifice was scarred and gaping evidently an inflammatory lesion.

The ureter in these cases on the side of the aplasia varied.

In Case 1 there was no evidence of ureteral orifice in any region of the bladder, urethra or vagina.

It is reasonable to suppose that the ureter and kidney are completely absent though Ivons reports a case in which a short rudimentary ureter was attached to the bladder in the normal position though there was no ureteral orifice present.

In Cases 2, 3 and 4 there was a short rudimentary ureter present which was patent for some distance. In two cases it ended blindly.

but in the third it was continued as a fibrous cord attached to the aplastic kidney tissue found in that region. In Cases 5 and 6 there was a urter present throughout dilated thickened and filled with purulent material each strictured in its lower portion.

A small renal pelvis was found in these two cases with thickened fibrous walls. No pelvis was found in Cases 3 or 4.

Evidences of renal tissue were found in 5 of these cases. There is no reason to expect any evident traces of renal tissue in Case 1. Many similar cases have been reported (1 to 11).

In each of Cases 3 and 4 there was found a small mass of fat and connective tissue containing nodules of firmer tissue and in two small thin walled cysts. These nodules and cysts were connected by bands of fibrous tissue. They were supplied by one or more small blood vessels and in one the fibrous cord passed downward to become attached to the lower and patent portion of the urter. Section of the nodules of tissue showed a predominating connective tissue matrix containing nests of cells epitheloid in character in many instances forming ducts the lumen of some containing albuminous material resembling cysts. In other portions rudimentary glomeruli could be made out. These were as a rule very few and many were replaced by fibrous connective tissue which in places showed hyaline degeneration. The cyst wall was lined by flattened epithelium and made up of connective tissue fibers. The cyst in Case 3 contained urea creatinin and sugar in the proportion similar to that found in blood.

In Cases 5 and 6 there was found a definite pelvis surrounded by a shell of tissue composed of connective tissue tubules and a few glomeruli many of which had been replaced by fibrous tissue. Whether these two cases are aplastic in origin or whether they are the result of secondary atrophy is a question not easy to answer. A case similar to Case 6 has been reported by Krotoszyner.

The differentiation between renal aplasia and secondary atrophy is difficult to make histologically. Kaufmann's *Pathology* states there is no essential difference in the histological picture. Oertel is of the opinion that in a secondary atrophied kidney there

is usually some evidence of a urter and a pelvis being present.

In all probability Cases 5 and 6 might fall into the class of atrophic cases but whether the atrophic process commenced in a kidney which was normal or in one that was hypoplastic in nature is impossible to say.

Hinman's work as well as that of Barney and of Scott tend to show that ligation of the urter causes a hydronephrosis rather than an atrophy so that one may assume that the two latter cases are congenital in origin.

CONCLUSIONS

The conclusions to be drawn from this series of cases may be summarized as follows:

1. Unilateral renal aplasia is not uncommonly seen in urological practice.
2. The lesion appears to be more common on the left side than on the right.
3. There is usually a lesion of the opposite or remaining kidney.
4. There is sometimes unexplained pain on the side of the aplasia.
5. The operation and removal of the rudimentary kidney relieved the pain in cases for some unexplained reason.
6. In some cases nodules or cysts containing renal tissue are found without pelvis or urter formation.
7. The aplastic kidneys in this series were all functionless.

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CARCINOMA OF THE ESOPHAGUS

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 R. J. T. H. L. T. H. P. H. L. G. H. H. P. H. L. L. L. D. P. M.

THE esophagus is a musculomembranous tube about 5 centimeters (10 inches) in length connecting the pharynx and the stomach beginning at the lower border of the cricoid cartilage between the sixth and seventh cervical vertebra about 15 centimeters from the incisor teeth and ending below the diaphragm opposite the tenth (some time the eleventh) thoracic vertebra. The subdiaphragmatic part is about 3 centimeters long. Four areas of contraction are commonly agreed upon although others have been described. Of these one is at the very beginning, a constriction at the point where the arch of the aorta crosses the esophagus and the fourth where the latter passes behind the origin of the left bronchus. They all seem to be closely related to the positions in which cancer occurs and will be shown later.

The lymphatics of the esophagus which are of peculiar importance in the explanation and understanding of metastasis of esophageal cancer are arranged in two networks, one of which is submucous, the other in the muscular coat. The stems which drain the networks of the cervical portion of the esophagus pass to the superior deep cervical and retropharyngeal nodes, those draining the thoracic portion of the network to the posterior mediastinal node and those originating in the network of the terminal portion pass to the nodes of the caeliac group. From these three groups of nodes there is hardly any limit to the metastases of lymphatic in the neck, chest and abdomen, a fact which can readily explain some of the extensive metastases of cancers of the esophagus. The extensive submucous network of lymphatics will explain in most instances why local lesions may become so large before more distant metastases occur. The close proximity of the trachea and bronchi and of their lymph nodes to the esophagus and to the esophageal nodes as shown in the photograph will ex-

plain why they so readily become involved particularly in growths situated in the middle third (Hiersol's *Analomies*).

For convenience the esophagus is frequently divided into thirds. The upper third extends from the cricoid cartilage to the point where the aorta crosses the trachea and esophagus. The middle extends from this point to 4 centimeters below the bifurcation of trachea or about the level of the lower edge of the fifth thoracic vertebra and the lower extends from this point to its junction with the stomach opposite the tenth thoracic vertebra. The bifurcation of the trachea occurs about the middle of the esophagus.

Analyzing 5,000 autopsies performed in the past 5 years at the Philadelphia General Hospital we found 51 cases of malignancy. Of the 41 (50 per cent) died of cancer of the esophagus. Of the 41 cases 39 (95 per cent) were males and occurred in the colored race. The oldest patient was 97 and died of cerebral hemorrhage. The cancer in this case was small and had not given rise to any complaint nor were there any metastases. The youngest patient was 41 and gave symptoms of increase in difficulty in swallowing for 24 months which was the longest duration of symptom of any of the cases. He had a grade 3 (Broder's) prickly cell carcinoma involving the upper part of the lower third of the esophagus for a length of 1 centimeter and at time of death it only partially obstructed the lumen of the organ. There was no distant metastasis of the growth but the local extension was of a fairly marked degree involving the trachea, mediastinal lymph gland and surrounding tissue.

Of the 41 patients the average age at death was 60 years and 6 months and the great majority were in their sixth decade.

SYMPTOMS AND DURATION OF LIFE

Difficulty in swallowing was by far the commonest symptom. It occurred in 9 cases and

was one of the first symptoms in 7 occurring very late in 7 and was the only symptom for a long time in 15.

Weakness and loss of weight were early and constant symptoms. They were the first symptoms in many cases and with the exception of one case were practically always present. This patient was a white man 73 years old and did not have any symptoms until months before death at which time he developed a cough with expectoration of bloody sputum four days before death for the first time he developed difficulty in swallowing. At autopsy he was found to have a grade 3 prickly cell carcinoma of the esophagus 3 centimeters below the cricoid cartilage. The growth was flat and encircled the esophagus for the length of 2½ centimeters. It had perforated into the trachea at this position and had given rise to a large superior mediastinal abscess but the lumen of the esophagus was only partially obstructed. The patient died of deglutition pneumonia.

Pain and vomiting were comparatively infrequent symptoms. Epigastric pain mostly of a mild degree was present in 7 cases of these 7 5 showed the growth to be in the lower third of the esophagus and in each instance to extend into the stomach. In the other cases the growths were present in the middle third but one of them had given rise to metastasis to the liver, coeliac glands and most of the abdominal organs. The other practically occluded the lumen for 5 centimeters but had not given rise to any local extension or metastasis. Only one patient complained of actual pain on swallowing. This pain was of a very severe degree and of a burning character occurring months before death and preceded by 3 months of difficulty in swallowing. The case showed an ulcerative hemorrhagic carcinoma involving the upper part of the lower third for 4 centimeters. The posterior mediastinal glands were slightly involved and there was a very large gland along the lesser curvature of the stomach. The involvement of the structures in this case was not different from many others who did not have pain and we were unable to determine its cause. Pleural pain occurred in 6 cases. In each the periesophageal tissues and structures were in-

involved in various degrees and pleural adhesions were present.

Vomiting was the earliest sign in 5 cases. Two of these were accompanied by nausea and metastatic ulcerative areas were found in the stomach. Regurgitation occurred in many cases and in each there was more or less obstruction.

Cough was a prominent symptom in 10 cases. In these the trachea, bronchi or lungs were involved or pressed upon with the exception of one where a metastatic mass surrounded the aorta and involved the recurrent laryngeal nerve. In 4 cases the trachea or left bronchus was perforated. There were examples of each.

Spitting of blood occurred in 11 cases in 6 cases from the metastases to the trachea, bronchi or lungs, in from ulcerative metastatic lesions in the stomach and in 3 from the esophageal lesions.

Hoarseness was present in 5 cases. Early symptoms as given in textbooks such as substernal pressure or discomfort or spasm of the cardiac end of the stomach were not mentioned.

Symptoms lasted as long as 4, 17 and 15 months, the shortest duration varying from none at all to 3 weeks. Three gave no symptoms referable to the esophagus at all in one the lesion was small, in another the lesion involved the middle third for 8 centimeters and had metastasized to the peri-bronchial and pancreatic lymph glands. The patient was in a moribund condition on admission and the history obtained from relatives who may well have been inaccurate. The third case was a well nourished white man 72 years of age, his history was also given by relatives. The esophageal lesion was small and flat arising in the upper part of the lower third of the organ and metastasizing widely throughout the chest and abdomen. A few cases had symptoms referable to the esophagus for 1 to 3 weeks. For the most part these growths were flat and produced very little obstruction but were not very different in local character or extent of metastasis from those giving rise to long standing symptoms.

Some of the lesions causing complaints for the longest periods of time peculiarly were

end of the stomach giving rise to an ulcer 2 centimeters in diameter. The edges of the ulcer in the stomach were raised and indurated and its base presented an irregular and indurated surface. The oesophagus above the ulcerating mass presented several firm and small elevated areas beneath and covered by the mucosa. The cancer extended through the middle third and on section were of the same character as the mass below. At the bifurcation of the trachea the lymph nodes were enlarged and were replaced by tumor tissue. The oesophagus was adherent to the trachea just above its bifurcation and at this position the growth had infiltrated into the mucosa of the latter but had not perforated through.

Similar tumor nodules as large as 1 centimeter in diameter were scattered throughout both lungs. The lymph glands at the hilum were involved. Both adrenals were replaced by the tumor and both kidneys contained numerous hard white nodules to 2 centimeters in diameter. The liver was studded with tumor nodules and the mesenteric lymph nodes were matted together and replaced by the tumor tissue. The neck of the humerus was destroyed by a similar tumor growth. Microscopic sections showed the tumor tissue in each of these organs to be a typical prickly cell carcinoma. Broder's classification grade 4.

THE EXTENT AND DIRECTION OF THE METASTASES ACCORDING TO THE POSITION OF THE LESIONS IN THE OESOPHAGUS

The middle third was most frequently the seat of the primary lesion and the center of the lesion was most commonly above the area of constriction where the oesophagus is crossed by the left bronchus. In the lower third the lesions appeared to have originated usually about the area of constriction where the oesophagus passes through the diaphragm. We could not be sure in the larger local growths that these two areas of constriction were the points where the growths began. In many of the smaller lesions we could be more positive that they did begin at the areas of normal anatomical constriction (Table I).

TABLE I—SITES OF THE OESOPHAGEAL CANCERS

	c
Upper third	4
Middle third	19
Middle and lower third	4
Lower third	14

Upper third. Of the four growths occurring in the upper third one involved the oesophagus for a length of 5 centimeters and gave rise to

no metastases. The cancer was of the prickly cell variety grade and the patient's symptoms were of only 6 weeks duration. He died following a gastrostomy.

The three other growths gave rise to extensive metastases in the chest similar to but not so marked as the second case described in the preceding pages. Two of these lesions perforated into the trachea and in only one did metastases occur below the diaphragm and this was only one small nodule in the liver. In the cases that metastasized the lymph glands of the neck and superior mediastinal glands were more extensively involved than the posterior mediastinal glands (Table II).

Middle third. Of the nineteen cancers occurring in the middle third six did not give rise to any metastases. In five of the remaining cases there were no metastases below the diaphragm while in three of these the metastases were extensive above the diaphragm. There were no cases that metastasized below the diaphragm that did not also metastasize above it which will be seen to be different from the lower third growths.

Eight of the middle third cancers gave rise to extensive metastases above the diaphragm, two of which also extended to the abdominal organs involving the liver, most of the lymph glands, both kidneys and adrenals. In one of the eight the only metastasis below the diaphragm was a small nodule in the right kidney. Another showed the only metastasis below the diaphragm to be in the scrotum and to involve the testicle. The other cases in which metastases occurred below the diaphragm only the lymph glands at the fundus or along the lesser curvature of the stomach were involved.

The posterior mediastinal glands and peribronchial glands which are shown in the photograph were the first to become involved and when any metastases occurred they were always involved. Many cases showed them to be involved when no other structures were and their close proximity to the growth is very evidently the explanation (Table III).

Middle and lower thirds. These four cancers involved the middle and lower thirds to such an extent that we were unable to determine in which of them the growth started. With the exception of one they metastasized widely

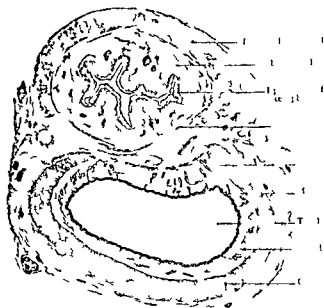


FIG. 1. Transverse section of trachea and oesophagus of child seen from below. (From Peters *Anatomy*)

In 2 other cases the metastases were extensive above and slight below. One occurred in the upper third and the other in the middle.

Grade 3-12 cases. The average duration of life after the first onset of symptoms was 5 months. Extensive metastases occurred in 5 cases, moderate metastases in 5, slight metastases in 5, and no metastases occurred in 2 cases. Of the cases of this group that did not give rise to any metastases, one did not have any complaints referable to his oesophagus and the growth was small. The other case had symptoms for only 3½ months and the local lesion involved the oesophagus for 7 centimeters. We were in doubt on microscopic study whether we should have called this a grade 1 or 2 prickly cell cancer. Of the cases where only a slight metastasis occurred, one had given rise to symptoms 5 months, another 4 months, and the third had not given rise to any symptoms, and in 2 of them the local lesions were small.

Of the cases in which metastases were moderate, one gave symptoms 3 months and the other 4 months. The first cancer locally was small but the second involved the oesophagus for 10 centimeters.

Grade 1-5 cases. The average duration of life after the onset of symptoms was 8 months and 7 days. Extensive metastases occurred in

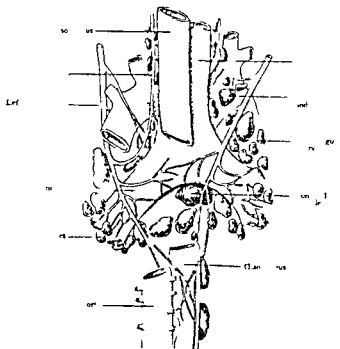


FIG. 2. Trachea and bronchial lymph nodes viewed from behind. (From Peters *Anatomy*)

5 moderate metastases occurred in 4, slight in 1, and no metastases in 5. Of the cases giving rise to extensive metastases, the shortest duration of symptoms was 6 months and the longest duration of symptoms was 10 months. The average duration was about 8 months. In all of the cases the local growths were large and involved the oesophagus for an average length of 1 centimeter.

Where the metastases were moderate, the longest duration of symptoms was 12 months and the shortest was 4½ months. The local growths were large and involved the oesophagus for an average length of 8 centimeters. The case which had only very slight metastases in the immediate oesophageal lymph glands had complained for 11½ months and the local lesion was 4½ centimeters long. The shortest duration of symptoms in the cases in which no metastases occurred was 1½ months, the longest was 15 months, and the average was 7 months. The local lesions in these cases were smaller than the others but averaged 6 centimeters in length, the largest being 10 centimeters.

Grade 1-3 cases. There were only 3 cases of this type and the average duration of life was 16 months. One of these had had

TABLE III—CANCERS OF MIDDLE THIRD—Continued

Age	Symptom	Type	Extent of lesion	Metastasis	
				Above diaphragm	Below diaphragm
M 43 385	Intermittent dysphagia (lost my 5 m)	P M llig d	Ob t t g th s m by m f P f rat l t t t	Nec t l t l ft b h d t f d t	N
M 67 684	Dysphagia l k bef	P kl llig d	P t l b t t f g t g d l g m g m l g t	N	N
M 54 99	P m D m t m t l g d m t g	P kl llig t s	M t t p p t f m l l th d l g t th kn f oesoph u Se oca b k	P t m t t m nod t t t th gh both d	L t l d l La g t m k l y m L th m m ol les Mes l y mph gl d t e

symptoms for 4 months and the growth had given rise to extensive metastases in the chest and to a few lymph nodes of the celiac chain. The other 2 had caused symptoms for 17 and 7½ months respectively and the local lesions were large but had not given rise to any metastases.

Only one tumor was of the basal cell character and involved the middle third for 8 centimeters but had not caused any metastases. Case 2 described in detail in the preceding pages was a very malignant adenocarcinoma.

SUMMARY

Of the 41 cases of oesophageal carcinoma comprising this study metastases occurred below the diaphragm in 2. In 9 of these the metastases were extensive in 11 metastases occurred in the liver in 8 only the glands at the fundus of the stomach and the celiac chain were involved. There were 4 instances in which the metastasis occurred below the diaphragm without any above it and all of the primary growths were fairly large involving only the lower third of the oesophagus. In one metastasis occurred in the liver kidneys adrenals and lymph glands in the others it was limited to the celiac and mesenteric lymph glands. Metastasis limited above the diaphragm was present in 9 cases and in 4 instances it was extensive. There were 18 cases in which the metastasis occurred both above and below.

Ten of the cancers or about 3 per cent did not show any metastasis but one however had perforated and had given rise to an

empyema. Two of them were prickly cell cancers grade 1, 3, grade 2, grade 3, and 1 was a basal cell cancer.

As brought out in the preceding pages the cancers of the higher grades that did not give rise to metastases were of a short duration.

DISCUSSION

Dr Chevalier Jackson in a paper on "Why Can Surgeons Not Cure Cancer of the Oesophagus?" brought out many interesting points in which he rightfully condemned many of the procedures in the diagnosis of cancer mentioned in surgical textbooks. He states that the oesophagoscope and X-ray are the only two methods of procedure to be used and that the lesion can readily be diagnosed with the oesophagoscope when it is no larger than an orange seed.

The greatest difficulty with early diagnosis of cancer does unfortunately not depend on our present day methods of procedure but upon the fact that cancers of the oesophagus do not cause recognizable symptoms until very late.

The oesophagus does not have very sensory nerves for which reason the earliest symptoms are reflex. Substernal discomfort or spasm of the cardiac end of the stomach are two early symptoms in some cases. Most commonly difficulty in swallowing causes the patient to apply for treatment and usually by the time this symptom occurs the lesion is fairly extensive and may or may not have metastasized depending upon the degree of

TABLE V—CANCERS OF THE LOWER THIRD

Age	Symptoms	Type	Extent of local	Metastasis	
				Abdominal	Extra-thoracic
M 49 5974	Loss of weight, dysphagia, vomiting, epigastric pain	P. kl. llg d	Ulcerating, infiltrating, fistulous, perforating	P. oesoph. lgl. ls	Ulcerating, fistulous, perforating, extra-thoracic
M 56 645	Regurgitation of food, loss of weight, dysphagia	P. kl. llgr d	Obstructing, infiltrating, fistulous, perforating	N	N
M 49 69	Weakness, dysphagia, vomiting, epigastric pain	Sq. m. llgr d 4	Extensive, infiltrating, fistulous, perforating, metastatic	Extensive, infiltrating, fistulous, perforating, metastatic	Extensive, infiltrating, fistulous, perforating, metastatic
M 6 55	Loss of weight, dysphagia, vomiting, epigastric pain	P. kl. llgr d	Obstructing, infiltrating, fistulous, perforating	N	N
M 69 747	Bleeding, dysphagia, vomiting, epigastric pain	P. kl. llg d 3	Ulcerating, infiltrating, fistulous, perforating	N	N
M 4 384	Intermittent dysphagia, vomiting, epigastric pain	P. kl. llg d 3	Intermittent, infiltrating, fistulous, perforating	Metastatic, infiltrating, fistulous, perforating	Metastatic, infiltrating, fistulous, perforating
M 6 99	Dysphagia, vomiting, epigastric pain	P. kl. llg d t	Perforating, infiltrating, fistulous, perforating	N	Gastrointestinal, lymphatic
M 55 896	Loss of weight, dysphagia, vomiting, epigastric pain	q. m. llg d 4	Perforating, infiltrating, fistulous, perforating	Gastrointestinal	Fistulous, extra-thoracic
M 6 866	Metastatic, dysphagia, vomiting, epigastric pain	P. kl. llg d 4	Extensive, infiltrating, fistulous, perforating	Extensive, infiltrating, fistulous, perforating	Metastatic, extra-thoracic
M 68 899	Dysphagia, vomiting, epigastric pain	Pr. kl. llg d 3	Obstructing, infiltrating, fistulous, perforating	Oesophageal	Extensive, infiltrating, fistulous, perforating
M 58 993	Regurgitation of food, loss of weight, dysphagia	P. chl. llgr d 3 4	Perforating, infiltrating, fistulous, perforating	Perforating, infiltrating, fistulous, perforating	Gastrointestinal, extra-thoracic
M 7 7454	Weakness, dysphagia, vomiting, epigastric pain	P. chl. llg d	Perforating, infiltrating, fistulous, perforating	Metastatic, infiltrating, fistulous, perforating	Gastrointestinal, extra-thoracic
M 6 7579	Dysphagia, vomiting, epigastric pain	Sq. m. llg d 3	Perforating, infiltrating, fistulous, perforating	N	Lymphatic, extra-thoracic
M 59 547	Perforating, infiltrating, fistulous, perforating	Sq. am. llgr d 3	Ulcerating, infiltrating, fistulous, perforating	Metastatic, infiltrating, fistulous, perforating	Extensive, infiltrating, fistulous, perforating

can be determined to a fairly accurate extent with the microscope. The position in which the cancer occurs in the oesophagus does not have any relation to the extent of metastasis but does have some relation to the direction of metastasis.

Cancers of the upper third metastasize to the glands in the superior mediastinum or deep cervical glands. Those of the middle third most commonly involve the lymph glands around the bifurcation of the trachea. They metastasize below the diaphragm less

commonly and less extensively than do those involving the lower third. Cancers of the lower third most commonly metastasize below the diaphragm and this is through the coeliac chain.

The surgeon roentgenologist œsophagoscopist and pathologist working together should be able to tell from the degree of malignancy of the biopsy gross description and individual character of a case whether metas-

tasis has likely occurred and if it would be worth while to subject the patient to an operation of high mortality such as resection of the œsophagus. It seems unlikely that radium will have any place in the treatment of these cancers for the wall is involved deeply and in most instances if the cancer cells alone could be picked out perforation would occur and the patient would die of empyema abscesses or some chest complication.

INJURIES OF THE LARGER ARTERIES

ENCOUNTERED IN CIVIL PRACTICE

By BENJAMIN HUSHKIN, M.D., F.A.C.S., PHILLY, PA.
MAY 1911

INJURIES of the larger trunk of the blood vascular tree constitute but a small percentage of the accident encountered in civil practice. While numerous statistics based on experience gained in the recent and past wars are present concerning wounds of the blood vessel, injuries of the blood vascular tree in civil practice are usually not the result of gunshot wound. But what chiefly distinguishes civil vascular injuries from those observed during war is their different ætiology and in the mechanism of their production. Not included in this study are the injuries of large vascular trunk inadvertently inflicted during the course of an operation for such wounds are under the direct control of the surgeon.

The present study is based upon 9 cases due to variety of causes, explosion of over charged ether bottle, fracture dislocation of humerus, contusion without a ribbed bone injury.

(1) Illustrating a case of right common carotid artery right pleural cavity and left lung.

Incident of simple age 24. The injury followed the intravenous explosion of an over charged empty bottle of ether. The burst of the ether caused immediate loss of consciousness. The patient was revived by artificial respiration. The patient was taken to the hospital and the bottle was found to be empty. The patient was taken to the hospital and the bottle was found to be empty.

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ultrahigh pressure immediately in every direction. The patient's neck and supraclavicular space were immediately packed with sterile gauze. The patient was taken to the hospital and the bottle was found to be empty.

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Ligation of the external carotid artery was carried out above the origin of the lingual artery. Convalescence was smooth and uneventful.

CASE 3. Stab wound of the right common carotid artery and the internal jugular vein.

Patient was a colored female age 24 years. Following a marital altercation patient received a knife thrust in the right side of her neck inflicted by her gentleman friend. Examination showed that the knife blade was embedded to its very hilt in the right side of the neck. The site of the stab thrust was about 1/2 inches cephalic to the middle of the clavicle.

Fortunately no attempt was made to remove the embedded weapon before the patient was sent to the hospital. At operation an incision was made in the neck along the anterior border of the sternomastoid muscle above and below the embedded blade. On withdrawing the embedded blade from the neck a most alarming gush of blood ensued. The common carotid and internal jugular vein were rapidly ligated *en masse*. The necessity was for rapid and immediate control of the hemorrhage. Whether the vagus nerve was included in the ligation cannot be stated. The patient suffered no immediate or later ill effects from the ligation for she made a complete recovery.

CASE 4. Laceration of the left axillary artery following the reduction of a dislocated shoulder (reported through the courtesy of Dr. J. H. McCarthy).

Patient was a male age 67 years. Following the reduction of a subacromial dislocation of the shoulder a definite swelling appeared in the left axilla which gradually increased in size. The patient became pale and short of breath. The radial pulse on the affected side was not palpable. A wound of the axillary artery was suspected and operation was carried out 1 hour after the time of the reduction. An incision was made in the axilla and the subscapular artery was found torn away from its point of origin from the axillary. Ligation of the axillary artery was performed above the origin of the subscapular. The patient died in 36 hours. Autopsy showed a complete severance of the subscapular artery as it arises from the axillary artery.

CASE 5. Wound of the brachial artery associated with a compound comminuted fracture of the humerus.

Patient was a male age 30 months. Injury was sustained by patient being hit with an automobile truck. On admission to hospital patient was in profound shock and the entire left extremity was almost avulsed. Shock treatment was instituted. Debridement of the wound was performed and fracture fragments were placed in fair alignment. The brachial artery was ruptured about 3 centimeters above the bend of the elbow. The latter vessel was ligated. Convalescence was stormy. Some infection occurred in the wound but the circulation in the extremity at no time appeared impaired. On discharge from the hospital 10 weeks after the accident the functional result was about 50 per cent. The humerus was well united and the circulation in the injured extremity presented no impairment.

CASE 6. Stab wound of the external iliac artery.



Fig. 1. The popliteal fossa illustrating the proximal and distal division of the popliteal vessels. An anomalous tendon is here seen which has its origin from the short head of a biceps muscle and inserts in a fan shape into the posterior medial aspect of the capsule of the knee joint. The little muscle acts as an additional flexor of the joint.

Patient was a female age 50 years. She was first seen about 30 minutes after the occurrence of the accident. She was pulseless, practically exsanguinated and unconscious.

There was a small innocent stab wound present about 1 centimeter medial to the left anterosuperior spine. This wound was the result of a stab thrust effected by the blade of a long stiletto. It was impossible to account for the sudden and complete collapse of the patient except upon the basis of an injury to one of the larger arterial or venous trunks. Shock therapy was immediately instituted. At the same time under local anesthesia a rapid exploratory exposure of the iliac vessels was carried out. The entire retroperitoneal space was occupied by a massive hemorrhagic extravasation. On removal of the extravasated hemorrhage the external iliac artery 1 centimeter below its origin from the common iliac was found severed for about 1/2 of

In most of the reported cases the carotid ligation was carried out for a pulsating exophthalmus an aneurism of the carotid artery or as a preliminary measure in operation for malignancy of the head and neck so that much of the available information concerning the effects and dangers of carotid ligations is based on this data. The possible development of encephalomalacia with a resulting hemiplegia is always an impending danger in the ligation of the carotid artery. Sattler in 17 ligations for pulsating exophthalmus notes 17 fatalities upon the completion of the ligation.

In rabbits ligation of one common carotid artery produces no noticeable effect on the animal. In a number of instances both common carotid arteries were ligated and the result was always fatal. In man the incidence of encephalomalacia depends upon a number of factors: first the general state and age of the patient; second the presence or absence of changes in the vessel wall—it was a teaching of Kocher that to tie the common carotid artery in a person past middle life was always dangerous and in the arteriosclerotic equivalent to a death warrant—third the manner of application of the ligature; fourth the variations in the vessels forming the circle of Willis. Concerning the last the observation of a large number of brains in the neuro-anatomy laboratories of the Jefferson Medical College discloses the fact that variations in the circle of Willis are a rather common finding. Particularly significant is the presence of an exceedingly small posterior communicating artery or complete absence of the latter vessel. Such anatomical variants undoubtedly affect the outcome of some cases.

Many of the carotid ligations cause no disturbance. Occasionally the evidence of cerebral disturbances does not appear for some hours or days after the application of the ligature.

The opinion has been expressed by a number of able observers notably Perthes (21, 22) that the cerebral disturbances following carotid ligations are due to thrombus formation and resulting emboli. The relation of thrombus formation to a sudden and forcibly applied ligature has been noted particularly by

Sigerist. In an analysis of 80 fatalities following ligation of the common carotid artery he noted an ascending thrombus extending toward the head from the site of ligation 4 times. The thrombus foundation was the direct result of a sudden and forcibly applied ligature.

John Hunter was first to call attention to the importance of avoiding injury to vessel walls in the application of a ligature.

The contusion of a large vessel causes definite slowing of the circulation even though the vessel is uninjured. Probably the vascular contraction noted in the operation of arterial sympathectomy can be interpreted in the same way. The vessel narrows for a time. The narrowing causes an increased resistance to the circulation because of the narrowing of the lumen of the artery while the arterial pressure centrally remains unchanged. Injury to the vessel wall particularly the intima and slowing of the circulation are among the chief causes of thrombus formation. If the blood stream flows with its accustomed force it may tear a small thrombus from the site of vessel injury and the beginning thrombus would then form an embolus. Or the thrombus may grow into one of the adjacent collaterals and interfere with the developing collateral circulation or may form another embolus. In brief traumatism of the vessel and a change in velocity of the blood stream may be directly responsible for the formation of a thrombus and possible emboli.

The application of a ligature to large vascular trunks must be slow and gentle either fascia or a thick coarse thread being used as tape. In this way one tends to eliminate injury to the intima one of the chief causes of intravascular clotting. In the young with soft elastic walls it is possible to occlude the lumen of the vessel without injury to the intima but in the sclerotic vessel with its friable intima it is almost impossible to ligate an artery without intimal trauma. This latter fact represents the great danger of carotid ligation in the old.

Secondary hæmorrhage can as a rule be prevented as noted by Blair (1) in heeding the advice of Billroth neither to suture any wound in the floor of the mouth nor to suture

it circumference. No other vessel trauma was present. The wound in the artery was sutured and the circulation above the site of injury was controlled by tapes. When the suturing was finished pulsation of the vessel below the site of suture was easily visible. Within 48 hours definite evidence of arterial occlusion appeared in the dorsum of foot below the malleoli showing signs of gangrene. A line of demarcation was present in 4 days. On the sixth day after the occurrence of the injury amputation was performed about 5 centimeters above the line of demarcation. The tissues were anemic pale gray and did not bleed. Fifteen days later revision of the amputation stump was carried out. The tissues no longer freely throbbed muscles were relaxed and full of life. A lateral circulation had established itself well within the 3 week period.

The patient at the present time has a useful weight bearing stump extending in the below the tubercle of the tibia and is able to perform all of her household duties with relatively little discomfort. Her general health is excellent.

CASE 2. Wound of right femoral artery in the result of a compound comminuted fracture of the upper third of the femur.

Patient a male age 28 years truck driver was thrown off his truck and sustained a massive wound of the upper end of the right thigh. On admission to the hospital he was in profound shock. In addition bleeding was continuous from a massive laceration on the ventral surface of the thigh. Shock treatment as instituted for the femoral artery in a ligament. The upper end of the femur was markedly comminuted. Within 12 hours after admission no spontaneous effort he was unable to move.

Autopsy showed complete comminuted fracture of the upper third of the femur the fracture fragment had torn through the femoral artery and vein.

CASE 3. Subcutaneous rupture of the left popliteal artery and vein following the active mobilization of a stiff knee joint.

Patient a female age 34 years was admitted to the hospital for the purpose of breaking up the stiffness about the knee joint. The affected articulation was stiff with less than 10 per cent of the normal range of movement present. Clinical and X-ray examination of the joint showed that the limitation of movement was due to periarthritic inflammation and not to bony ankylosis. Endorhizoidic anasthesia the knee was actively mobilized. Within 1 hour after the mobilization the leg became cold slightly cyanotic and edematous.

No pulsation was palpable in either the posterior tibial or peroneal arteries in the area above the popliteal region. Conservative treatment in the form of heat elevation and immobilization produced no effect and the clinical evidence of gangrene continued to advance. An amputation through the lower third of the femur was carried out 5 days after the initial mobilization of the stiff knee joint. Dissection of the amputated extremity showed a

rupture of the popliteal artery and vein midway between the adductor hiatus and the bifurcation of the popliteal artery into its anterior and posterior arteries.

CASE 4. Subcutaneous rupture of the popliteal artery and vein the result of a football tackle.

Patient was a male age 18. While playing football he was tackled vigorously and roughly about the right knee and thrown to the ground. Sudden and increasing pain was immediately present in the right popliteal region. He was unable to flex or extend the knee. The popliteal fossa showed a moderate swelling which appeared to be increasing. In number of hours induration and moderate swelling of the calf were noted. Palpation of the posterior tibial and peroneal arteries could not be palpated. Because of the severe increasing pain and swelling over the right popliteal artery and the induration the leg operation was advised on the basis of a possible vascular injury. Operation was carried out 10 hours after injury. The right popliteal fossa was exposed through a long posterior incision. A hematoma of considerable size was present and dissected. The popliteal artery was almost completely severed and occupied by small thrombus. The popliteal vein also showed a lateral tear. The artery was ligated between 2 ligatures instead of a ligature in continuity. The popliteal vein was also ligated. The induration of the calf of the leg was palpable the result of so called anemic induration for there was no hæmorrhagic extravasation present in the calf of the leg.

The wound was closed without drainage. On the third postoperative day about 2 ounces of sequestrum were removed from the incision. Other complications as smooth and healing as by first intention. He was kept in bed for 21 days. The circulation of the leg is good presents no swelling but has a moderate foot drop which he never has interpreted him in any way.

CAROTID ARTERY

Wounds of the common carotid artery are preferably treated by suture. The nearer the injured vessel is to the heart the less likelihood there is for a suture repair of the vascular wound to be followed by thrombus formation beginning at the suture line. Frequently however the associated trauma permits only the application of a ligature. In the greater proportion of the reported cases of carotid artery wounds ligation of the injured vessel was the usual procedure. Haberer (4, 5, 6) reports 8 cases in which the wound in the common carotid artery was sutured, carotid and 5 lateral in one case ligation was later made because of secondary hæmorrhage. Of the 8 cases 7 recovered and 1 died.

reality a maneuver of active self reduction on the part of the patient and depends essentially upon the premise postulated by Sherrington. No anesthetic is required, thus the necessity of all manipulative force being reduced. This method of reduction is carried out as follows.

The arm is placed so that the elbow rests against the anterosuperior spine of the ilium. The arm is first raised slightly in the sagittal plane. The patient is instructed to perform external rotation forcibly, the latter movements being aided by the surgeon who at the same time adducts the arm. The simultaneous action of the opposing movement of external rotation and abduction and adduction with internal rotation permits the head of the humerus to slip quietly into the glenoid cavity. There is no audible click on reduction when this technique of reduction is practiced. It is carried out more easily and rapidly than the Kocher and other methods and tends to eliminate the hazard of arterial injury.

In the case of the popliteal artery additional anatomical relations render this vessel more prone to injury from a confuting force. The vessels of the lower extremity particularly in the popliteal space are in more intimate relation to the bone. Figure 1 illustrates the proximal fixation of the popliteal artery and vein at the adductor hiatus where it is firmly fixed by the adductor magnus tendinous arch. Distally these vessels are again fixed by the tendinous arch of the soleus muscle and by the interior tibial artery as it passes through the interosseous membrane. The anatomical nearness of the popliteal artery to the posterior surface of the femur and its proximal and distal fixations are the latent anatomical factors which explain its subcutaneous vascular rupture, the result of a severe confuting injury without an associated bony injury.

Cases 8 and 9 are illustrative instances wherein the popliteal vessels were ruptured yet no bony injury was sustained. The active causes of these popliteal vessel wounds were as follows. Case 8 resulted from active mobilization under anesthesia of a stiff knee joint. Case 9 resulted from being tackled in a football game. In the majority of instances the suddenness of the applied violence or

movement induces a marked tension and distention of the vessel wall. The elastic tissue of the vessel wall offers but little protection against injury from a sudden violence in the case of the popliteal artery. The maximum distention of the vessel wall may not be reached but the suddenness of the violence ruptures the vessel because of its natural anatomical fixation.

The mechanism of this vascular wound has been aptly compared to a taut string which is held firmly fixed at either end, should a sudden pressure or pull be applied its center would tend to give away.

Pictured in Figure 1 is a large anomalous tendon which courses obliquely across the popliteal space. Certainly this tendon when present would act further to fix the popliteal vessels. While the finding of such a tendon is a rare event it must be recognized that the subcutaneous rupture of the popliteal vessels is also a rare occurrence.

Wounds of the popliteal artery which are the result of dislocation of the tibia have been reported in a number of instances. Schulz (5) reports the occurrence of a popliteal rupture in a young adult following the reduction of a dislocation of the tibia. Bruenner (3) reports 4 instances of subcutaneous ruptures of the popliteal artery, 3 of which resulted from dislocations of the tibia.

Here again the anatomical fixation of the vessels and the well known fact that when the leg is extended the popliteal vessels do not rest on the bony surface account for a possible rupture of the popliteal vessels if the leg is suddenly overextended as in an anterior dislocation of the tibia.

COLLATERAL CIRCULATION

Certainly the establishment of an adequate collateral circulation following the ligation of a large vascular trunk must take some time. In the experimental ligation of large arteries in animals the development of a definite collateral circulation takes from 15 to 21 days depending upon the vessel ligated and the site of the ligation. It is well to remember however that large arterial trunks can be ligated in animals with considerable less fear of gangrene than in man.

without free drainage any wound that contains a ligated carotid or a ligated primary branch of the external carotid. In the ligation of large arteries it is best however scrupulously to avoid drainage.

The prognosis in carotid ligation appears to be more favorable when it is combined with the simultaneous occlusion of the internal jugular vein. In spite of some differing opinions concerning the latter procedure the observation of Oppel, Hager, von Mikulicz (16) and others show that the hazard of arterial ligation is definitely lessened when combined with the simultaneous occlusion of the accompanying vein. Yet Luder (17) who has had an extensive experience with arterial injury in a case carried out the simultaneous ligation of the common carotid artery and internal jugular vein and in each instance definite postoperative cerebral thromboses followed. The ligation of the accompanying vein even though uninjured simultaneously with the wounded artery will be decided under the general heading of treatment.

ANATOMICAL FIXATION OF THE VESSEL

The importance of the anatomical fixation of blood vessels and of the contributing factor in the location of vascular injuries following a certain mechanism of injury or mechanism. Such anatomical fixation are present at the site where branches of considerable size take origin. In time of the latter is the site of origin of the subclavian and posterior humeral circumflex from the axillary artery and the bifurcation of the pectoral artery into the anterior and posterior humeral.

Clinically the anatomical fixity well illustrated in the type of vascular injury of cervical incident to the occurrence or to the reduction of a dislocated shoulder. The greater projection of the axillary vessel reported in case of axillary artery wound associated with a dislocated shoulder show that the type of vascular injury encountered is that either the subclavian or posterior humeral circumflex artery is torn away from its point of origin.

Koerte (10, 11) in 1885 reported such accidents in his own experience. In 190 he added another personal case and collected 44 cases from the literature. Of the 44 collected

cases one half of them were in recent dislocation and in more than one third of the latter group the vascular rupture took place during the act of reduction. In only 3 of the 44 cases group was it definitely established that the arterial wound occurred with the dislocation. Furthermore in 6 instances of the 44 the vascular wound occurred during the reduction at all 4 locations. Koerte considered 2 months or more as an arbitrary time division period between recent and old dislocation. Stimson (18) in 1885 reported 44 axillary artery wound and following dislocation of the shoulder. Of the 44 cases 12 recovered and died.

The noteworthy fact concerning the association of axillary artery wound with dislocation of the shoulder is that this vascular injury occurs in the majority of instances from the movement in maneuvers usually practiced when a dislocated shoulder is reduced. Extensive violence and excessive traction must be avoided. The presence of arteriosclerosis necessitates extreme care in reduction. It is when the reduction is difficult that a wound of the axillary artery is likely to take place. In the reduction of an old dislocation particular care must be exercised and an open operation in the axilla procedure at the reduction cannot easily be effected. In the Kocher method of reduction is not without danger in the report for marked pressure on the axillary vessel is produced in carrying out the Kocher method of reducing a dislocated shoulder.

The prevention of the possible occurrence of the injury merits a brief consideration. Formerly there was a general belief in the importance of the ligament for the fixation of joint but at present there is a tendency to believe that the tonic activity of muscles is the most important factor. In his series of marvelous experiments Sherrington shows that in ordinary movements muscles obey the law of reciprocal innervation. Antagonistic muscles exert synergistic action and fix the joint.

Clinton (19) has developed a method of reducing a dislocated shoulder which the writer has used in a modified form with uniformly successful and satisfactory results. It is in

vascular trauma present would have seemed to render a fatal issue inevitable yet recovery ensued without an operation. Injuries which involve both the artery and its accompanying vein appear to show a greater tendency to spontaneous cessation of hemorrhage. The spontaneous healing of arterial trunks partially or completely divided has come to light largely by discovery of the vascular lesion in the course of operations upon nerves. Makins remarks that the great majority of these instances are due to contusion. Vascular lesions which are the result of a severe contusion may not effect a complete break in the vessel wall. Herzog (4) in 50 such injuries found the intima alone injured 9 times, the intima and the media 21 times. Sebestyen (6) questions whether the spontaneous cessation of hemorrhage occasioned by an injured vessel is not dependent for its cessation upon the equalization and balance of pressure. Thus small vessels bleed less for the pressure is easily balanced. He believes that the bleeding stops spontaneously when the pressure of the extravasated blood in the tissues is as great as the pressure of the blood in the injured vessel. Obviously the contraction of the vessel wall is also a factor. The injury of the popliteal femoral or of some other large vascular trunk may temporarily stop bleeding in the absence of an obstructing thrombus.

Should evidence of progressive hemorrhage exist and the hematoma present increase in size operation is indicated without delay. The deliberate delaying of operation in the presence of a large hematoma the result of an injury to one of the large vessels has two hazards: first the pressure of the hematoma on the surrounding vessels which interferes with their participation in the establishment of a collateral circulation—the true causes of gangrene when it occurs after ligation or suture are those which interfere with the establishment of the collateral circulation—second the danger of infection of the hematoma for with infection besides sepsis there is the additional hazard of a secondary hemorrhage. Infection is probably the most frequent cause of secondary hemorrhage.

The danger of hemorrhage following the removal of a retained foreign body deserves

mention. Such a retained foreign body may act as a vascular plug or may control bleeding from an injured vessel by pressure and its removal may set up a most alarming hemorrhage. The surgeon must have this possibility in mind in the removal of a retained foreign body lying in the neighborhood of large vascular trunks and be prepared before and during the operation for such an emergency. Case 3 is an example in this group. The patient a colored female was admitted to the hospital with the blade of a knife embedded in the left side of the neck so that only the handle protruded. Fortunately no attempt was made to withdraw the embedded weapon before the patient was transferred to the operating room. When the knife was withdrawn a most alarming hemorrhage ensued. Both the carotid and jugular vein had been severed. The wounded artery and vein were ligated. Recovery was uneventful.

The question as to whether the injured vessel should be treated by the obliteration ligature or the conservative suture has been admirably summed up by Mats (19). LaRoque (14) and others and the consensus of opinion decidedly favors the ligature. The decision in favor of the aseptic ligature is based on the end results, that ligation is usually an easy procedure and the suture often a difficult one is entirely outside the question.

In two of the cases included in the series of arterial injuries (external iliac common carotid) repair of the injured artery was carried out by careful suture. In both instances definite thrombus formation resulted extending cephalad from the line of suture. In regard to thrombotic occlusion the experimental evidence shows that even in the best conditions in laboratory animals the suture especially the circular suture is liable to a very considerable percentage of failures through thrombotic occlusion or cicatricial stenosis. Before the war Mats collected from the literature reports of 49 circular sutures which had been performed in civilian hospitals and in peace conditions. A careful analysis of the available postoperative evidence showed that 13.1 per cent had been followed by gangrene. Of the 37 patients who recovered in no less than 33 (87.6 per cent)

In Case 2 in which the external iliac artery was sutured gangrene of the foot developed probably as the result of thrombus formation at the suture line. An amputation was performed within 4 centimeters of the line of demarcation at which time the muscles were pale dull gray in appearance and the entire procedure was free from bleeding. Three weeks later a revision of the stump was carried out and the appearance of the tissues found markedly changed. The muscle were red glowing with a healthy normal color and bleeding from the cut tissues was most active. The time for the establishment of the collateral circulation in this instance was within the week period.

Many studies of imputed extremities supplemented by later dissections of the specimens appear to indicate that the arteries accompanying the various nerves are among the most important of the vessels concerned in the formation of an adequate collateral circulation. Experimental ligation of the femoral artery shows that the establishment of an efficient collateral circulation following the ligation depends mainly upon the sciatic artery. The vasa nervorum accompanying the various nerves are sometime vessels of some size and in addition they anastomose freely with other arterial twigs to form a continuous vascular network. When a large vascular trunk is occluded or ligated the vasa nervorum undergo an increase in their lumen establishing an excellent collateral circulation. Variation in the caliber and in the anastomotic arterial network of the vasa nervorum are vital factors in the formation of an efficient collateral circulation.

The pure morphological factor and its relation to the development of a collateral circulation is not sufficiently recognized and has not been given the attention it deserves. While in the main the variations of the larger arterial trunks tend to conform to a number of well defined anatomical types, the variations of the smaller arterial twigs are so highly individualistic as to defy analysis. And it is not unlikely that such arterial individualism if means of recording and measuring them were possible would be as distinctive as one's finger prints.

Attention has been particularly focused on the question of pressure exchange of substances in the vessel and vessel walls the tonicity of the capillary bed and tissue needs but the pure morphological element is usually overlooked. The marked variations in the blood vascular tree surely must have no little influence in the establishment of an efficient collateral circulation. In a number of studies on the variations of the blood vascular tree (15, 16, 17) it is noteworthy that a finding of definite hypogenesis of the blood vessels occurs in approximately 8 per cent of all cadavers. This hypogenesis consists of definitely smaller calibered blood vessels and a decrease in the number of branches. The microscopic image confirms the latter finding for the examination of a considerable number of arterial walls show a wide variation in the general mural structure. The elastic content, the muscle content, etc. exhibit wide variation. In some instances the vessel because of its faulty mural structure appear almost fragile in other cases strong and robust. Such findings are recorded independent of age and disease and represent distinct morphological types.

Conversely considered the presence of additional branches, the presence of accessory arteries are not uncommon findings in the experience of any observant anatomist.

Surely such factors as outlined above represent important elements concerned in the formation of an excellent collateral circulation entirely apart from the pure physico-dynamic factor. The writer in no way underestimate the physico-dynamic factors concerned in the formation of a collateral circulation but desires to call attention to this morphological aspect.

TREATMENT

Wound of the blood vascular tree in which the evidence of hemorrhage is not severe and no continuous increase in size of the hematoma appears may for a time be treated conservatively. Numerous observations are present to show that the spontaneous cessation of hemorrhage is possible in case of injury to large vessels. There are a number of remarkable instances on record in which the

must be applied gently to occlude the lumen of the vessel without intimal injury. Studies by Schreffer (24) at the Baugh Institute of Anatomy on the obliteration of the lumen of blood vessels indicate that injury to the endothelium incident to ligation may result in intravascular clotting and thrombus. In one series of ligations thrombosis was of common occurrence while in a second series it was rare. Halsted, Holman and others advise the use of coarse ligatures such as tape rather than fine ligatures which may cut through the arterial wall. This has been our practice. In the one popliteal ligation the artery and vein were divided between ligatures instead of ligating in continuity. Holman has again directed attention to the value when feasible of dividing the vessel between two ligatures. He considers this procedure preferable to ligation in continuity.

My best thanks are extended to Dr. J. I. Schreffer, head of the Department of Anatomy of the Jefferson Medical College for his generous help in obtaining all of the available material and to Dr. J. I. Dunlop, head of the Institute of Anatomy.

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by circular suture with and without interposed grafts the anastomoses had proved functionally valueless or superfluous if we are to judge by behavior of peripheral pulses.

The margin of the safety must always lie whether with the suture or ligature in the integrity of the collateral circulation. A properly applied ligature suffices to meet almost every pressing indication. From my own small clinical experience ligation (external carotid popliteal common carotid brachial) has resulted in recovery.

The value and the necessity of ligating the accompanying vein even though uninjured in case of arterial ligation is variously interpreted. The study of any problem concerning the blood vascular tree must represent a consideration of the circulatory system in total perspective, a decided hemodynamic apparatus subject to potential variations and oscillation. Many believe that the danger of arterial ligation is greatly decreased by the simultaneous ligation of the accompanying vein. The clinical experience of Makin, Oppel, Hagern, Torn, Schulz and St. John (20) and Holman in the experimental study of the problem by Brook (1) and Holman (8) has decided for it in the incidence of gangrene when the artery and vein are simultaneously occluded. In two of the included case reports both the artery and vein were ligated (popliteal in common carotid) and the recovery was without note in each instance. Holman advises the ligation of common femoral vein above the deep femoral or external phenomenon in ligation of the popliteal artery in order under certain circumstances to increase the capillary resistance in the thigh and by directing the force of the collateral circulation into the anastomotic channel to lessen the possibility of gangrene. Ligation of the vein nearer the heart is recommended after ligation of popliteal artery and vein if gangrene is suspected but it must be performed before true gangrene supervenes.

Makin believes that the combined procedure maintains within the limb the miller amount of blood supplied by the collateral circulation. Whatever may be the factor that determines the formation of an efficient collateral circulation surely pressure must be

an important one for change of pressure interferes in some degree with the necessary stimulus for vascular dilatation and exchange of substances through the capillary walls. Blood is serviceable to the tissues in the capillary region only and there is a definite relation between blood pressure and permeability. Furthermore in the examination of capillary beds there is a distinct difference between arterioles and capillaries. Between the capillaries and venules the difference is much less pronounced. The muscular walls of many venules are so thin and incomplete that the exchange of substances through their walls must be considerable and in some cases the vessels which are classed as veins are from a physiological point of view to be regarded as capillaries. Simultaneous ligation of the artery and vein would seem to maintain a more equitable pressure equilibrium in the important functioning capillary bed. While the caliber of the capillaries is mainly determined by their own tonus it is of course also affected to a certain degree by the blood pressure (for blood). In some experimental studies concerning the value of the combined procedure Krimpholtz (19) of Sauerbruch's clinic advises against the ligation of the vein. He used the kidneys as the basis of his work but his results are by no means convincing. The fact that the arteries and capillaries in normal subject vary greatly and the fact that the power to resist internal pressure is developed to a different degree in the capillaries of different tissue are entirely overlooked. Without an attempt to add to the thesis too heavily with the phrase of vascular surgery, the balance of opinion both clinical and experimental strongly favors the simultaneous ligation of the artery and vein. The only contraindication to the ligation of the vein is noted by Brook as evidence of obstruction in the collateral vein.

The operation in case of internal wound necessitates a generous exposure of the injured vessel. Every effort must be made to conduct the operation aseptically in order to eliminate the hazard of thrombosis and infection. Drainage in vascular surgery must be scrupulously avoided. Packing and drainage as Holman notes invite disaster. The ligature

TABLE I—THE EFFECT OF CHLOROFORM AND ETHER ANÆSTHETICS ON THE CARDIAC OUTPUT AND BLOOD PRESSURE

D t	W ght kgm	P l t pe m	T m p t f	A t O l pe	V O l pe	A V D f t pe	O m p pe	C l ac t m m	O t p e kgm pe m	O t p e t m	M blo l p es mm Hg
3 p m t l tudy	3.6	6	93.6	8.81	43	6.36	83	357		3	25
3 55 p m fte hlo f m f s m tes	3.6	5	93.6	8.81	116	6.48	87.4	333	95	7	4
4 5 p m fte hl f m f s m tes	3.6	55	93.6	9.56	6	7.9	8.8	15	77	9	9
5 p m c t l tudy	3.6	7	99	9.4	84	5.4	87.4	6	8		9
5 55 p m ft th f 45 m tes	3.6		99	9.6	4.83	4	97	359	74	9	

samples. Arterial blood was obtained by puncture of the left ventricle or one of the femoral arteries and venous blood by puncture of the right ventricle. The blood gas determinations were made on the Van Slyke-Neill (17) manometric apparatus. The circulatory minute volume was calculated from the Fick formula

$$\frac{\text{C cm O}_2 \text{ consumed per minute}}{\text{Amount O}_2 \text{ taken up in lung by 1 cm of blood}} = \frac{\text{No. cm of blood fl in through the lung per minute}}$$

When the effect of more than one type of drug was studied the same animal was used and sufficient time was allowed to elapse for complete recovery from the previous anæsthetic.

RESULTS

The results are divided for convenience into three groups according to the type of anæsthetic employed.

I Ether anæsthesia. Previous experiments upon the effect of ether anæsthesia are reported in detail elsewhere. The present studies are of interest mainly in the comparison which they afford with the other two anæsthetics.

The experiments with ether anæsthesia were performed upon 8 animals, 5 of which were trained and remained quiet during the control studies without a narcotic. The same results were obtained with both the trained dogs and those which were given morphine. The cardiac output increased during the administration of the ether anæ-

sthetic in each of the 8 experiments, the percentage increase over that during the control period varying from 1 to 44 per cent. The oxygen consumption usually remained about the same and the utilization of oxygen (arterial oxygen content minus venous oxygen content) decreased in 7 of the 8 experiments. The pulse rate was accelerated in all instances. The blood pressure was determined in 3 experiments. At the beginning of the anæsthesia there was a marked rise in blood pressure which rapidly declined but the blood pressure then remained at a slightly higher level than that of the control period. The results of three typical experiments are given in Tables I, II, and III.

II Chloroform anæsthesia. Fifteen animals were used in this study, 8 of which were trained and did not require a narcotic. It is believed that the degree of anæsthesia which was obtained with chloroform was usually not so deep as that with ether. The pulse rate usually increased but not so much as with ether. The oxygen consumption was decreased slightly in most experiments. The utilization of oxygen was increased in all instances except two. Changes in the cardiac output paralleled alterations in the arteriovenous difference rather than changes in oxygen consumption. The decrease in minute cardiac output varied from 4 to 50 per cent, the amount of decline seeming to be directly proportional to the depth of the anæsthetic. The average decrease in the cardiac output

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D t	W ght kgm	P ls t pe m	T p t F	A t O V l pe t	V O l pe t	A V D f V l t	O C mp m	C lac tp m cm	O tp t kgm m	O tp t p b m	M blood p es mm Hg
3 p m t l t dy	13.6	6	98.6	8.84	48	6.36	83	387		3	5
3 55 p m ft l f m f 15 m tes	3.6	5	98.6	8.84	36	6.48	86.4	333	98	7	4
4 5 p m ft hl f m f 25 m t	3.6	55	98.6	9.56	64	7.9	8.8	45	77	9	9
5 p m t l t dy	3.6	7	99	8.4	84	5	86.4	6	8		9
5 55 p m ft th f s m t	3.6		99	8.96	4.88	4	97	359	74	9	

P to c l m b t h 6 c l f m p h t t l m 3 p m t t l d t m t 3.4 p m h f f m x th beg 3.55 p m
ht bl d ac tp t l l o o p es t t l f f es bt t t p t t 4 7 p m 5 f m t l d t m t 5.4 p m th r x th
beg 5 55 p m mal est t l t f f es bt t t p t t 4 7 p m 5 f m t l d t m t 5.4 p m th r x th

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III EFFECTS OF ETHYL CHLORIDE AND ETHYL CHLORIDE ANESTHETICS ON THE MINUTE CARDIAC OUTPUT AND BLOOD PRESSURE

AN EXPERIMENTAL STUDY

BY MILDRED BLOCK, M.D., F.R.C.P. (LOND.)

F **I** **L** **N** **O**

THE death rate which is ascribed to the administration of various anæsthetics is remarkably low at the present time. The fact is due in large part to the increased information concerning the physiological action of the drugs, and to the careful consideration as to the choice of anæsthetic in each individual case. However, studies upon the actual output of the heart of the intact experimental animal have been neglected since it is thought that this is one of the best means of determining the condition of the circulation. The present study was attempted. Many of the observations, such as the determination of the blood pressure and by the non-invasive technique of perfoming with the thoracic patient, but studies upon the actual output cannot be carried out because of the danger of puncturing the heart and of the uncertainty of its effect on the life. Hence it was necessary to use animals in the study.

The prevailing idea among the investigators and their colleagues on the regulation of heart rate is that the modulation has been found mainly in relation with the pressure and form of the venous return to the heart. Some of the work has revealed findings of great significance, but factors in terms of such evidence to the output of the heart in intact animal is not just a small amount in time, has been found to be erroneous. In previous experiments (1) it was found that either could in man in the cardiac output provided the animal were not too deeply anesthetized. It was also found that the amount of increase in the cardiac output from the administration of ether could be lessened by the intravenous injection of an alkali or by the previous administration of digitalis. In the present report the changes which were found during ether anesthesia are of interest only in comparison with the

change in tel when chloroform and ethyl chloride were administered to approximately the same level. Many previous reports on the histologic use during the administration of various type of anesthetic are found in the literature and the present figure are of interest only in relation to the change in the arterial output.

MR CHOD

The tube nictol of S_2 determination of the cardiac output of 4 dogs. Eleven of the animals were trained to remain quiet with at nictol while the remaining animals were given morphine (usually 0.6 gram) at 10 h before the control observation were made. The blood pressure was determined in the ear sized animal.

At a normal room air control determination in the infants the \dot{V}_E was administered through a jet in the nose. The degree of arterial hypoxia probably variable but in attempt was made to give general relaxation and stimulation of the infant reflex. When the desired level of methemoglobin was obtained blood samples were drawn with the cone in place and during the continued administration of the methemoglobin. The oxygen consumption was then determined immediately after removing the cone by methemoglobin open to air but in the change in oxygen consumption were small and since the animals were usually deeply anesthetized it is presumed that the error is small.

The wagon assumption was determined by means of a Benchet pirometer with a graph recording device. The animal was connected to the pirometer by means of a rubber mark () which fitted tightly over the mouth.

The usual precautions against contact with air were observed in the collection of blood

TABLE III—THE EFFECT OF CHLOROPHOSPHATE ETHER AND ETHYL CHLORIDE ANESTHETICS ON THE CARDIAC OUTPUT

[illegible]

sidered. The present report consists of a series of observations on the cardiac output and blood pressure during ether chloroform and ethyl chloride anesthetics. No attempt has been made to determine the manner by which these changes take place. However the findings by other experimenters are of interest in this regard.

Kodama (9) studied the output of adrenalin by the suprarenals during ether and chloroform anesthesia. The output was found to be diminished by both of these anesthetics. Since the cardiac output is affected differently by the two drugs it does not seem likely that the change is instituted by the adrenals.

It is known that anoxæmia may be associated with any of the anæsthetics under discussion. Harrison and Block (8) have found that anoxæmia of a severe degree causes an increase in the cardiac output. However the arterial blood was normally saturated with oxygen in practically all of the present experiments and no relationship seemed to exist between the percentage saturation and the cardiac output. Leake and Hertzman (10) state that it is impossible to maintain anæsthesia under nitrous oxide and oxygen with

out some increase. Although the effect of nitrous oxide on the cardiac output of the intact animal cannot be studied satisfactorily by available methods it seems probable that an increase in the output of the heart is associated with it.

Various observers have found that ether and chloroform cause an increase in the hydrogen ion concentration of the blood. Harrison, Wilson and Blalock (7) studied the effects of acidosis and alkalosis on the cardiac output of dogs. Injection of large amounts of acid caused an increase in the cardiac output while the injection of alkali resulted in a decrease in the cardiac output. Previous studies (1) have shown that all of the increase in the cardiac output during ether anesthesia is not due to the acidosis which is produced. Since the administration of chloroform causes an increase in the hydrogen ion concentration of the blood and a decrease in the cardiac output it seems likely that the change in the output of the heart is not due to alterations in the reaction of the blood.

As regards the effect on the peripheral circulation Cushny (4) states that both ether and chloroform dilate the vessels when they

TABLE II—THE EFFECT OF ETHYL CHLORIDE, ETHYL AND CHLOROFORM ANESTHETICS ON THE CARDIAC OUTPUT AND BLOOD PRESSURE

Experiment	Wt.	Temp.	Pulse	Arterial Pressure	Venous Pressure	Cardiac Output	Circulation	Oxygen	Blood
1	1.1	37.5	110	110	110	110	110	110	110
2	1.1	37.5	110	110	110	110	110	110	110
3	1.1	37.5	110	110	110	110	110	110	110
4	1.1	37.5	110	110	110	110	110	110	110
5	1.1	37.5	110	110	110	110	110	110	110
6	1.1	37.5	110	110	110	110	110	110	110
7	1.1	37.5	110	110	110	110	110	110	110
8	1.1	37.5	110	110	110	110	110	110	110
9	1.1	37.5	110	110	110	110	110	110	110
10	1.1	37.5	110	110	110	110	110	110	110
11	1.1	37.5	110	110	110	110	110	110	110
12	1.1	37.5	110	110	110	110	110	110	110
13	1.1	37.5	110	110	110	110	110	110	110
14	1.1	37.5	110	110	110	110	110	110	110
15	1.1	37.5	110	110	110	110	110	110	110
16	1.1	37.5	110	110	110	110	110	110	110
17	1.1	37.5	110	110	110	110	110	110	110
18	1.1	37.5	110	110	110	110	110	110	110
19	1.1	37.5	110	110	110	110	110	110	110
20	1.1	37.5	110	110	110	110	110	110	110
21	1.1	37.5	110	110	110	110	110	110	110
22	1.1	37.5	110	110	110	110	110	110	110
23	1.1	37.5	110	110	110	110	110	110	110
24	1.1	37.5	110	110	110	110	110	110	110
25	1.1	37.5	110	110	110	110	110	110	110
26	1.1	37.5	110	110	110	110	110	110	110
27	1.1	37.5	110	110	110	110	110	110	110
28	1.1	37.5	110	110	110	110	110	110	110
29	1.1	37.5	110	110	110	110	110	110	110
30	1.1	37.5	110	110	110	110	110	110	110

as 8 per cent. Change in the oxygen content of the arterial blood were negligible. Arterial anoxemia was not found in any instance. The decrease in the oxygen content of the venous blood was usually quite marked. Chloroform and the ether usually resulted with a decrease in the carbon dioxide content of both the arterial and venous blood. The mean blood pressure was found to be lower during the anesthetic in each case in which it was determined.

The results of three typical experiments are given in Table I, II and III. Figure 1 and 2 contrast graphically the effect of the three anesthetic under consideration.

III *Ethyl chloride anesthesia*—The experiment with ethyl chloride and the ether were performed on 11 animals of which did not require a narcotic. It is much more difficult to study the effect of the drug, because of the very narrow zone which separate the lethal from the therapeutic dose. A great variation in result was obtained depending upon the degree of anesthesia.

The inhibition of ethyl chloride caused only a slight increase in the pulse rate. The

oxygen consumption was usually slightly increased. Change in the arteriovenous difference were variable but it was usually slightly increased. Arterial anoxemia encountered in two experiments. The average change in cardiac output was +14 per cent but the change varied from +10 to +24 per cent. The mean blood pressure was elevated during the early part of the anesthetic but then returned to a level slightly below the control line. The average change in blood pressure at the time of the determination of the cardiac output was -1 per cent.

It is seen from the experiment that the effects of ethyl chloride are quite variable. The early stage of the anesthetic are thought to be associated with a slight increase in the cardiac output while deeper narcosis cause a marked decrease. The effect on the circulation seem to be intermediate between that of ether and chloroform.

DISCUSSION

The factor which may possibly explain the increase in the cardiac output during ether anesthesia have been previously con-

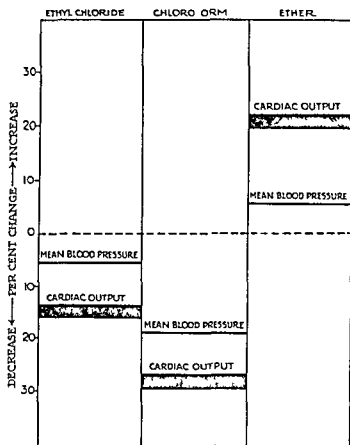


FIG. 2 This figure presents graphically the average percentage change in all elements in the cardiac output and blood pressure. The striking difference in the effect of ether and chloroform is not worthy of comment.

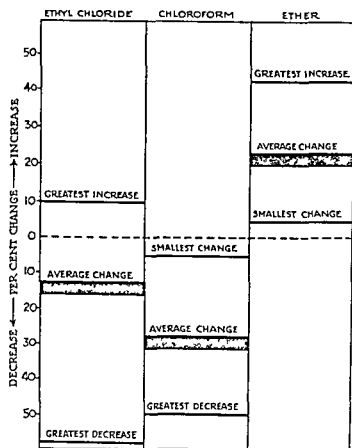


FIG. 3 It is to be noted in the present experiments that ether anesthesia caused an increase in the cardiac output in every instance that chloroform caused a decrease and that the effect of ethyl chloride was variable.

vagus inhibition. These latter observations together with the present report suggest that the factor of primary importance in regulating the cardiac output during the inhalation of these three anesthetics is the action on the heart itself.

It is rather striking (Fig. 2) that the directional changes in the blood pressure during the various anesthetics are the same as those in the cardiac output but to a lesser degree. This fact emphasizes the stability of the blood pressure and suggests that the changes in blood pressure are secondary to alterations in the cardiac output.

It is impossible to state at the present time what effect these anesthetics have on the minute output of the heart of man. However, practically all drugs have similar actions on man and dog. Furthermore, the arteriovenous difference of blood from the femoral artery and vein has been determined in 4 patients before and during the administration of ether

anesthetic. The utilization of oxygen was decreased in each of these instances indicating a more rapid circulatory rate.

The findings with ethyl chloride are in support of the prevailing clinical impression that the margin of safety is small with this drug and that it is not suitable for long continued anesthesia. Since ether and chloroform anesthetics cause opposite directional changes in the cardiac output and blood pressure, it seems from the viewpoint of their action on the circulatory system that these two drugs should not be used interchangeably.

Our present knowledge of the advantages and disadvantages of these anesthetics in patients with heart disease is far from being complete. It is believed that the work here reported is a contribution toward the solution of this problem, but a final evaluation of the anesthetics which are employed in patients with cardiac disease cannot be made until more knowledge is available concerning the

EMPYEMA IN CHILDREN

A PRELIMINARY REPORT

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It has for many years been recognized that empyema in adults and empyema in children are in many ways dissimilar and as such present diverse problems to the surgeon and the physician. It is strange however that in the light of this knowledge many results of new and varied treatments have been reported without regard to the age of the patients involved. In some instances when a report on a series of children's cases has been made, no note is made of the definite age of the children involved. That this information is of the greatest importance is evidenced by the fact that the mortality from empyema is about four times greater during the first year than during the fourth.

It is the purpose of this paper to review a series of 371 cases of empyema in children and to study them with regard to age, year of incidence, and organism involved.

Of this group 67 were treated in St. Mary's Free Hospital for Children during the years 1909-1917 and 104 were treated in the Children's Section of New York Hospital (First Surgical Division) during the years 1913-1927.

All cases recorded in this series were definitely diagnosed as empyema by aspiration and the roentgen ray and all received surgical treatment. We have not included in this series a number of cases in which no surgical treatment was given due to the condition of the patients or cases which were found by autopsy to be empyematous after death caused by pneumonia.

The children treated at St. Mary's Hospital are for the most part from the poorer homes of New York City, the majority being of Italian parentage.

ETIOLOGY

Empyema in children is, as far as we can judge, always a secondary process usually arising from a previous attack of pneumonia.

In our own series fully 9 per cent of all cases were either complications of or sequelae to an attack of pneumonia.

Pneumonia	236
Chronic sinus	11
Bronchitis	8
Abscess of lung	1
Foreign body	2
Peritonitis	1
Tuberculo	1
Undetermined	10

Apparently general hygiene and social status seem to have some bearing on the incidence of empyema in children. This is based not only on personal observation but on personal communications with a number of pediatricians.

The condition is not so commonly seen during the first year of life as during the 6 years that follow, probably because of the high mortality from pneumonia found in infants under the age of 1 year. During the season of 1925-1926 there was only a single child under the age of 1 year treated for empyema at the hospital. This child was infected with a non-hemolytic streptococcus and recovered fully. During the same period of time there were 41 infants under 1 year treated for pneumonia. Of these 17 died, a mortality of 41.5 per cent.

Our figures are in agreement with those of Holt, who found the highest incidence from the condition during the second year. From then on it gradually declines until the ninth year.

The mortality, however, was much higher during the first year of life than during any of the succeeding years. As is shown in Table I, the mortality during the first year was 66 per cent, whereas during the second year it dropped to 33 per cent. Holt in his series of 104 cases at the Babies Hospital, New York City, found a mortality of 71 per cent in children under 1 year and 59 per cent in those

pathological physiology of the circulation particularly the minute output of the heart in circulatory disorders

The possible means by which these changes are instituted are discussed

SUMMARY

The cardiac output and the blood pressure of the dog have been studied during the administration of ether, chloroform and ethyl chloride anæsthetic. Some of these experiments were performed on trained animal while in others the animal were narcotized with morphine. The results were the same whether or not morphine was used.

The more significant findings are as follows:

1. Ether and the other caused an increase in the cardiac output in every instance. The mean blood pressure was slightly elevated during the anæsthetic.

Chloroform and the other were associated with a definite decrease in the cardiac output and blood pressure in every experiment.

The changes during ethyl chloride anæsthesia were more variable but usually consisted of a slight decrease in the cardiac output and blood pressure. It should be thought to be intermediate between that of ether and chloroform.

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EMPYEMA IN CHILDREN

A PRELIMINARY REPORT

By CHARLES L. FARR, M.D., F.A.C.S. AND MITCHELL LEVINE, NEW YORK
F m th D p tm t f S g y C H U U S M d I C H g

It has for many years been recognized that empyema in adults and empyema in children are in many ways dissimilar and as such present diverse problems to the surgeon and the physician. It is strange, however, that in the light of this knowledge many results of new and varied treatments have been reported without regard to the age of the patients involved. In some instances when a report on a series of children's cases has been made, no note is made of the definite age of the children involved. That this information is of the greatest importance is evidenced by the fact that the mortality from empyema is about four times greater during the first year than during the fourth.

It is the purpose of this paper to review a series of 371 cases of empyema in children and to study them with regard to age, year of incidence, and organism involved.

Of this group, 67 were treated in St. Mary's Free Hospital for Children during the years 1909-1917 and 104 were treated in the Children's Section of New York Hospital (First Surgical Division) during the years 1913-1917.

All cases recorded in this series were definitely diagnosed as empyema by aspiration and the roentgen ray and all received surgical treatment. We have not included in this series a number of cases in which no surgical treatment was given due to the condition of the patients or cases which were found by autopsy to be empyematous after death caused by pneumonia.

The children treated at St. Mary's Hospital are for the most part from the poorer homes of New York City, the majority being of Italian parentage.

ETIOLOGY

Empyema in children is as far as we can judge always a secondary process usually arising from a previous attack of pneumonia.

In our own series fully 90 per cent of all cases were either complications of or sequella to an attack of pneumonia.

Pneumonia	36
Chronic sinus	11
Bronchitis	8
Abscess of lung	1
Foreign body	2
Peritonitis	1
Tuberculosis	1
Undetermined	10

Apparently general hygiene and social status seem to have some bearing on the incidence of empyema in children. This is based not only on personal observation but on personal communications with a number of pediatricians.

The condition is not so commonly seen during the first year of life as during the 6 years that follow, probably because of the high mortality from pneumonia found in infants under the age of 1 year. During the season of 1915-1916 there was only a single child under the age of 1 year treated for empyema at the hospital. This child was infected with a non-hemolytic streptococcus and recovered fully. During the same period of time there were 41 infants under 1 year treated for pneumonia. Of these 17 died, a mortality of 41.5 per cent.

Our figures are in agreement with those of Holt, who found the highest incidence from the condition during the second year.¹ From then on it gradually declines until the ninth year.

The mortality, however, was much higher during the first year of life than during any of the succeeding years. As is shown in Table I, the mortality during the first year was 66 per cent, whereas during the second year it dropped to 33 per cent. Holt in his series of 64 cases at the Babies Hospital, New York City, found a mortality of 71 per cent in children under 1 year and 59 per cent in those



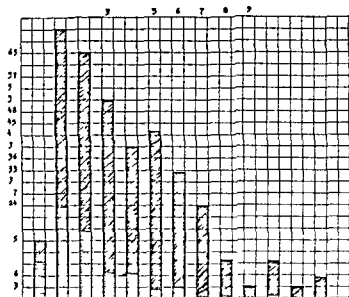


Chart 1 Age incidence of empyema in 371 children's cases. Stippled area indicates deaths.

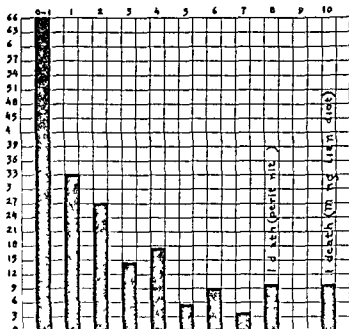


Chart 2 Mortality by age in 371 children's cases.

years that follow. In the first year we find the pneumococcus responsible for only 1 per cent of the cases whereas in the years that follow the number of pneumococcus cases averages around 60 per cent. This fact gains further weight when it is noted that the cases of pneumococcus empyema in children under the age of 1 year occurred during the same season (1919-1920).

On the other hand during the first year there is a much higher percentage in cases due to the streptococcus and to mixed infections. The latter is probably due to the fact that almost all pneumonias in children under 1 year are bronchopneumonias in type.

SEX INCIDENCE

In the 67 cases at St. Mary's there was a predominance of males over females. The mortality rate in males is also somewhat higher as shown in the following:

	N of Cases	N of Deaths	Mortality
Male	146	33	3
Female	121		1

The slight difference between the number of male and female cases in children bears a marked contrast to the condition as found in adults. In a series of 105 adult cases from the First Surgical Division, New York Hospital, we found more than two thirds of the cases

in men. A comparative study of these cases and our children's series will be included in a future article.

LOCATION

Of the 67 cases from the records of St. Mary's Hospital, 155 were on the left side, 105 were on the right side, and 7 were bilateral. Of 161 cases during the last 10 years the following figures were obtained:

	N of Cases	N of Deaths	Mortality
Left	96	3	4
Right	63	10	16
Bilateral	2	2	100

COURSE OF DISEASE

The most common symptoms found are the continued fever after the previous illness, the dyspnea, cough, and the condition of anorexia and general malaise. In some cases pain on respiration is found over the affected side.

Empyema can be easily diagnosed by a combination of physical signs, aspiration, and the roentgen ray. In several cases there was difficulty in diagnosis until roentgenograms were made, as the empyematous cavity was situated between two lobes of the lung at some distance from the chest wall. The average temperature during the acute process ranges from 101 to 104 degrees F. In some cases it ran above these figures and in some below.

TABLE I—AGE INCIDENCE AND MORTALITY

Age	Cases	Mortality	Mortality
0-1	15	1	6.7
2	13	2	15.4
3	5		14
4	10		8
5	43		5
	17		2
	1		4
		0	0
	0	0	0
	5	0	0
	4		

Table I shows the age incidence and mortality. The mortality rate is highest in the 2-4 age group, and lowest in the 0-1 age group.

Table I in the second year. When the Mount Sinai Hospital New York City in a study of 100 cases of infantile mortality, only 4 percent of the deaths were attributed to pneumonia.

After the first year the mortality rate is relatively low until the age of 10 years. After that the mortality rate is high in all the age groups, and is highest in the 10-14 age group.

The mortality rate is high in the 10-14 age group, and is high in the 15-19 age group. The mortality rate is high in the 20-24 age group, and is high in the 25-29 age group.

The mortality rate is high in the 30-34 age group, and is high in the 35-39 age group. The mortality rate is high in the 40-44 age group, and is high in the 45-49 age group.

The mortality rate is high in the 50-54 age group, and is high in the 55-59 age group. The mortality rate is high in the 60-64 age group, and is high in the 65-69 age group.

The mortality rate is high in the 70-74 age group, and is high in the 75-79 age group. The mortality rate is high in the 80-84 age group, and is high in the 85-89 age group.

TABLE II—NUMBER OF CASES AND PER CENT OF MORTALITY FOR VARIOUS YEARS SEASONS FROM JULY TO JULY

Cases	Deaths	Mortality
0-5	2	37
6-10	17	1
11-15	0	3
16-20	5	12
21-25	0	30
26-30	5	0
31-35	3	13
36-40	8	0
41-45	14	3
46-50	1	47

tion by the use of both conditions are usually caused by the same organism. The exact relationship between the two will be brought out in an article to follow on "The Cause of Death in Impetigo in Children and Adults: A Comparative Study."

The condition is most prevalent between the months of November and June, as shown in Chart 4. For this reason we have arranged our year from June to June rather than from January to January, since the latter obviously lightened and divided epidemic into two parts. An individual epidemic probably starts in October and continues to the June of the following year.

OF ANISME

The pneumococcus is the most common organism isolated, and a value found in empirical treatment with it, mortality of about 1 percent. Table III gives the determination of the pneumococcus.

TABLE III—PNEUMOCOCCI DETERMINATION IN 100 PNEUMOCOCCI POSITIVE CASES

Cases	Mortality
1-10	6
11-20	1
21-30	1
31-40	1
41-50	1
51-60	1
61-70	1
71-80	1
81-90	1
91-100	1

It has been classified according to the age of the patient in Chart 5. Although the number of cases contributed to our mind is sufficient, nevertheless several facts seem to be borne out. In the first place there is a marked difference between the pneumococcus during the first year and during the

Binney in 1904 reported a series of 100 cases treated with closed drainage of which 35 were in children from 1 to 10 years old. Of these there were 5 deaths or a mortality of 14 per cent.¹

In our series there were 359 patients under the age of 10 of whom 7 died a mortality of 20 per cent.

In spite of the scarcity of cases presented by Binney his results are of the least of great interest. It is of importance however to know the ages of the patients so treated the mortality for the various age groups and the year or years in which the cases occurred.

Ladd and Cutler report a series of 4 cases in which there were 12 deaths a mortality of 8 per cent. Although they do not give the age groups they state that the majority of the deaths occurred in infants in whom the mortality would have been high anyway. The figures in Table IV may be of interest concerning the relative merits of the open and closed method.

TABLE IV—RELATIVE MERITS OF OPEN AND CLOSED METHODS

	Cases	Deaths	Mortality	Operator
St. Mary's Hospital and New York Hospital (open)	31		19	1
Binney (closed)	35	5	4	
Ladd and Cutler (open)	6	36	10	4
Ladd and Cutler (closed)	4	1	5	50
Of all ages				

ANALGESIA

Of 150 cases operated on between 1916 and 1927 ether was used 138 times with a mortality of 16 per cent. Novocain was used 10 times with a 60 per cent mortality. The figures are as follows:

TABLE V—ANALGESIA

	Cases	Deaths	Mortality
Ether	138	6	60
Novocain	10	6	60
Ethyl chloride	1	0	
Chloroform	1	0	
By method of Ladd and Cutler			
St. Mary's Hospital & New York Hospital	138	6	60
Binney	35	5	4
Ladd and Cutler	10	36	10
Ladd and Cutler	4	1	5

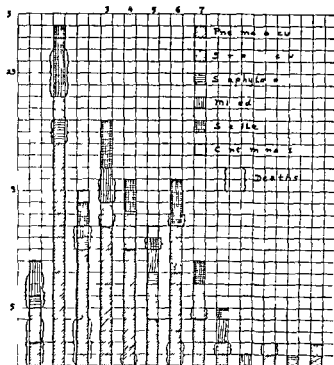


Chart. Percentage of mortality from empyema in child during the year 1916-1926

The above statistics are of little value inasmuch as the cases in which novocain was used were often of such a serious nature that general anesthesia could not be used.

A study was also made of the mortality by operators during the years from 1916 to 1927. In this series are included only operators with 10 or more cases (Table VI).

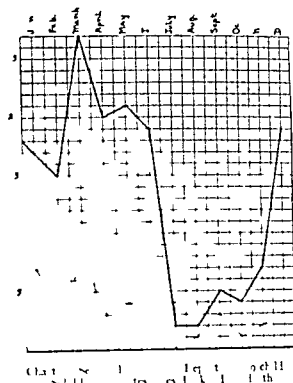
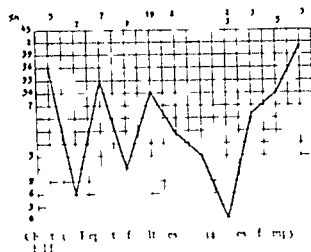
TABLE VI—MORTALITY BY OPERATORS

Operator	Cases	Deaths	Mortality
Dr. U	0	5	50
Dr. V	0	5	31
Dr. W	3	6	6
Dr. X	17	3	18
Dr. Y	1	4	15
Dr. Z		1	5

These figures are of little significance unless the following points are taken into consideration:

1. The tendency for certain operators to do only the more severe cases and let the interns do the others.

The seasons during which the operators were on service. (It is of interest to note in this connection that all the cases in which Dr. V operated occurred during 6 months of a year when the mortality rate was high.)



A study of the leukocyte and differential count prior to the operation. One hundred and one cases gave total count ranging from 10,000 to 40,000 with an average of 20,000. The neutrophils with a count of 10,000 and the lymphocytes with a count of 10,000. One hundred and one cases had a leukocyte count of 10,000. The neutrophils with a count of 10,000. The lymphocytes with a count of 10,000. The neutrophils with a count of 10,000. The lymphocytes with a count of 10,000.

On the differential count the lymphocytes were at the high percentage. The neutrophils were at the low percentage. The average count in the total was 20,000. The high percentage of the lymphocytes was 10,000. The low percentage of the neutrophils was 10,000. It will be seen that the percentage of the lymphocytes and neutrophils in the total leukocyte count. All the cases had a leukocyte count of 10,000. The high percentage of the lymphocytes was 10,000. The low percentage of the neutrophils was 10,000. The neutrophils with a count of 10,000. The lymphocytes with a count of 10,000.

TREATMENT

In all the first nine cases the operation was performed. The patient died from the pus but did not die from the nature of the fluid. In the very early cases with thin fluid a paracentesis was continued until condition favored open drainage. In only five cases was a paracentesis the only treatment. All of the patients dying. They were very ill and operation would probably only have hastened the end.

In all other cases open drainage was used. In one case in which a paracentesis was performed the patient died. In 165 cases with a death of 18 percent. Interocutaneous drainage with a paracentesis was used 8 times with a death of 12 percent. The high mortality found with the interocutaneous drainage is due to the fact that it was frequently used when the patient was critically ill and the general condition of the patient was such that the mortality rate of the cases in which operation took place at the hospital was of the order of 100 percent. Only interocutaneous drainage was comparatively low when compared with that of the other operation which rely chiefly on rib resection.

No case was treated by thoracic tube nor by a paracentesis followed by anti-toxic injection. Dickinson has been used without especially brilliant result. In order to clean the open cavity. With rare exception the benefit obtained in children has seemed to outweigh the advantages. It is a debatable question also whether drainage of the pleural surface is a wise measure in acute cases.

SEASON	0	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
15-16	2	OP 2111	2211	P 211	O 11	OSP 211	OO 11	1			1				22
16-17		SP 2111		P 2111	P 11	11	1	1	1		S 2				15
17-18	S 2	P 21		PO 111	O P 11	O P 11	P 111								13
18-19	2	OPP 211	P P 21	PPP 1111	PPOM 1111	P S 11		P 111					1	1	23
19-20	P P 21	POPP 2111	PO 211		S S 11		OPP 211	O P 11		M 1			S 1		20
20-21	M M 21	P 11	P 11	M P P 2111	P 11		P 21	P 11	M P 11					P 1	15
21-22		P 11	O 11	S N H P 2111	S 11	S 11		S 11			P 11				9
22-23			P 11	O 11		P S 11	S P P P 1111								8
23-24		P P 21	P 11		P 11	P 11	S 11								7
24-25	S N H 21	P 11	M P 21	P P 11	P P 21	S N H 11	S P 11	P 11	S 21				P 11		14
25-26	S N H 21	P O P P 2111	P P 21	P 11		P 11	S N H 21								12
TOTAL	10	31	18	26	16	15	17	12	4	1	3	1	3	1	158

PERITONITIS

Ch rt 6 14 h m d n t l t v b v f 58 t as P pn um S t pto c u st ph l
c c O t l 17 s d 11 h m l t

5 The year during which the operations were performed

4 The age of the patients

Dr Y used only the intercostal incision

COMPLICATIONS

Complications are frequent in empyema. Blocking of the exit is really an incident rather than a complication but it occurs very commonly and must be kept in mind when any untoward symptom develops. Locking is also fairly common but in children is usually simple easily detected and is easily remedied. Aspiration of the tube is occasionally seen. A rare accident is the unrecognized loss of part of the tube within the chest cavity. A roentgen ray or fluoroscopic examination should be made at not too long interval. The opposite chest can thus be kept under observation. Osteomyelitis of the rib occurs in a small proportion of the cases rather less in the intercostal type. Again the roentgen

ray is of the greatest assistance in detecting the presence and extent of the trouble. Necrosis of the rib is a fairly common cause for persistent sinuses and local pocketing. It rarely produces a late recurrence.

Acute anemia of varying degree is a constant complication of empyema. Repeated red cell counts and hemoglobin estimations should be made. The judicious use of blood transfusions is to be commended.

It may also be remembered in this connection that in drainage of the cavity the child is losing a great deal of body fluid as well as body proteins. It is therefore necessary to force fluids and to give plenty of nourishment. Bell has figured that adults lose as much as 21 grams of nitrogen per day.¹

The complications which occurred in 165 cases at St. Mary's Hospital during the years (1916 to 1927) are as follows

E A G h m d R D B n S m r n p l e l e d t h
m f m p y g Gynec & Ob g r n b o

Otitis media	C	1	Erysipelas	C	2
Pneumonia of same side	11	1	Peritonitis	2	2
Pneumonia of opposite side	8	1	Nephritis		
Bronchopneumonia	8	1	Pericarditis		
Lung abscess	6	1	Scarlet fever		
Pneumothorax	4	1	Gangrene of lung	1	1
Tonsillitis	3	1	Osteomyelitis of rib	1	1
Furunculosis		1	Bacteraemia	1	1
Tuberculosis		1	Chicken pox	1	1
			Measles	1	1
			Gastroenteritis	1	1

PROGNOSIS

The prognosis seems to be dependent upon a number of factors. The most important of these are age, complications, virulence of organism, condition of patient and treatment.

We have already shown the relation of age and virulence of the organism to the mortality and have pointed out the complications that occurred. It is of interest to note how ever that of 33 deaths occurring at St. Mary's between the years 1916-1917, 9 were complicated by serious conditions. Nineteen of these were symptomatic, were complicated by lung abscesses, 3 by peritonitis and the remainder by such conditions as pericarditis, gangrene of the lung, furunculosis and acute nephritis.

It would appear that the cases having resistance sufficient to outlast the first onslaught of infection and to localize it become surgical possibilities. Our mortality seems to be a measure of the intensity of the infection and the onset of severe complications. This is suggested by the postoperative day of death.

The average period of life in fatal cases was 15 days after operation. In the cases in which death occurred during the first 3 days in almost every instance the condition of the patient had been very poor at the time of operation. Deaths at a later period than this were usually due to severe complications.

In our series of cases there seemed to be little relationship between the time from the previous illness to the diagnosis of empyema and the mortality. It is probable that the thickened pleura which was found in a number of the fatal cases has some bearing on the final prognosis but in all cases it seemed to be of only secondary importance.

So far as the surgical treatment is concerned the most important factor is the

knowledge of when to operate. Operation before the pus is thick and the cavity well walled off increases the gravity of the prognosis to a marked degree.

CONCLUSIONS

1. Empyema is a complication in nearly all cases of a persisting and serious disease.

The incidence of empyema varies as regards age, year, season and organism. It probably bears a relationship to the prevalence of pneumonia and to the virulence of the affecting organism.

2. The mortality in infancy is very high. From then on it drops rapidly until the age of 7 and remains extremely low in adolescence and early adult life. Age seems to be the most important factor but the type of infection, the year and the virulence of the organism also have a great bearing on the prognosis.

3. It appears from the figures obtained that the time between the preceding illness and the diagnosis of empyema is only of secondary importance as regards prognosis, the main factors being the virulence of the organism and the general condition and resistance of the child.

4. Death from empyema in children is in almost all instances due to a general condition of debility brought on by the previous illness or due to existing complications and not to the empyema itself.

5. The various methods of treatment now in use—the use of the intercostal incision or rib resection, open drainage or closed drainage, Dain's solution or simple drainage—seem to have little influence upon the prognosis.

6. The time of operation following the diagnosis of empyema depends entirely upon the individual case and the surgeon should be guided by the nature of the pus and the general condition of the patient.

7. Recurrences seldom result if free drainage has been obtained and maintained until the closure of the wound.

DISCUSSION

DR. HOWARD LILLIENTHAL: Attention should be called to the importance of a proper estimate of the gross pathology in cases of empyema. It is not

scientific to consider a case of suppurative pleurisy as represented by a single cavity. The cause of empyema is usually infection from the surface of the lung and this may start from more than one focus. Indeed I have operated in many cases in which by free intercostal incision with ocular examination it was possible to identify several in one case as many as 5 different pockets each having apparently risen from a separate focus and no two alike as to the character of the exudate varying from seropus to thick pus. Indeed multiple empyema cavities were fairly common and frequently the different sacs contained different organisms. However I have found that as a practical method the primary treatment by trocar and cannula with the insertion through the cannula of a small multifenestrated rubber catheter about 14 F. with a very soft finger cot valve attached would in about one third of the cases re-

sult in a complete recovery without injection or lavage of the thoracic cavity. The cannula is removed leaving the catheter in place. The soft finger cot is then tied firmly to the end of the catheter outside the chest and finally a generous slit is made in the end of the finger cot. With every expiratory effort fluid with or without air is forced out while on inspiration the suction of the finger cot is sucked together preventing air or fluid from entering the chest.

If the course of the convalescence is uninterrupted the exudate gradually becomes serous and when X-ray examination demonstrates full expansion of the lung then the tube can be withdrawn. If however there is continued fever or other signs of sepsis an X-ray examination should be made after 5 or 6 days and other loculi of pus if discovered should be treated by more radical surgery.

OBSERVATIONS ON THE INTRAMURAL AND ISTHMIC PORTION
OF THE FALLOPIAN TUBES WITH SPECIAL REFERENCE
TO SO-CALLED ISTHMOSPASMBASED ON CLINICAL AND LIPOIDOL STUDY AND UTERO TUBAL INSUFFLATION IN 50 CASES
OF TUBAL OCCLUSION

BY I. C. RUBIN, M.D., F.A.C.S., NEW YORK

SINCE a method of localizing tubal obstruction has been found increasing attention has been given to the narrowest portion of the fallopian tubes which traverses the uterine musculature at either cornu. It is but natural to assume that this portion of the oviduct measuring as it does from 0.5 to 1 or at the most 1.5 millimeters in diameter might be occluded readily by inflammation and intra uterine tumors or temporarily obliterated by uterotubal spasm. As its function is to offer passage to the young impregnated ovum the presence or absence of anatomical anomalies and inflammation is of some importance in a consideration of the etiology of sterility. Certainly from a theoretical point of view spasm of the tubes particularly if its incidence can be proved to be as high as has been claimed must also be a causative factor.

Several publications have appeared recently dealing with the anatomical and pathological study of the intramural portion of the tube notably those of Hermstein and Neustadt (3) and of Geist and Goldberger (4). The conclusions of both papers are based upon skiagraphs made of injected extirpated specimens of uterus and tubes. The specimens were removed because of fibromyomatous alone or of bilateral disease of the adnexa or a combination of the two. Emphasis was laid upon the tortuosity, angulations and convolutions of the intramural portion in these cases—a condition which occurred according to Hermstein and Neustadt's report in 54 per cent out of 15 specimens examined. Geist and Goldberger in confirming these findings in the anatomical material go farther in their conclusions as applicable to problems in sterility. They claim that in an appreciable number of cases of sterility the tortuosity of the tubes at their

exit from the uterine cavity as found in the extirpated specimen is responsible for the high pressures reached during clinical utero tubal insufflation. They maintain this to be a cause of obstruction to spermatozoa and leave the impression that this condition is a factor in sterility more commonly than has hitherto been recognized. Other clinical deductions made by them are based upon their anatomical study.

Of the specimens studied by Hermstein and Neustadt 9 were resurrected from among specimens which had been immersed in formalin solution for some time and the remaining 6 were removed from the fresh cadaver. Mercury was used by them in the injections. The specimens studied by Geist and Goldberger were removed by operation injected with 0 per cent sodium iodide solution and skiagraphed before being immersed into formalin. The latter authors believed that they were dealing with living organs because of their fresh state.

There can be no question as to the importance of these anatomical studies as such or of the careful and painstaking work reported by these authors. But the interpretation of their findings and conclusions because of their clinical implication may be subjected to further scrutiny.

1. Neither the formalinized specimen nor the so called fresh specimen maintains the functional conditions found in the living intact organ or in the *surviving* extirpated organ. The uterus and tubes removed at the operation unless properly preserved in suitable oxygenated solutions die rapidly and undergo the changes of rigor mortis. It is a common observation that tubes become markedly contracted and thicker as soon as they are removed from the body. The tube lumen can thus become more sinuous especially at the intersti-

Total absence of tube	
History of previous laparotomy for pelvic diseases	1
History of no operation	3
History of previous dilatation and curettage	3
<hr/>	
Total number of cases	18
One tube only	
History of previous laparotomy for pelvic diseases	4
History of no operation	5
History of previous dilatation and curettage	3
<hr/>	
Total number of cases	12
In a case with bilateral short stump of tube no operation was done	
In a case with unilateral short tube stump no operation was done	
Both tubes	
History of previous laparotomy (not pelvic)	6
History of no operation	5
History of previous dilatation and curettage	3
<hr/>	
Total number of cases	14

4 The frequency of intramural closure by anatomical aberration or inflammation according to Geist and Goldberger although no figures of the number of specimens examined by them are given is apparently so great as to make it a matter of much importance in fertility. They report: "In about 40 per cent of the cases it (the intramural portion) passes in a gently direct course with the convexity upward through the wall of the uterus until it emerges. Occasionally it rises in a steep curve more or less abruptly from the uterine funnel. In the remaining cases the course is not a simple direct one but tortuous either traversing the uterine wall in a series of gentle convolutions up to four in number or in a course marked by decided angulations either one or two in number. In the angular course the tube usually rises sharply from the uterine cone to within a few millimeters of the peritoneal surface then sharply bends downward until it emerges occasionally just before or at its point of departure from the uterus it again makes a sharp angle giving it an L shaped point of exit or other bizarre form. Also."

We found frequently a definite oedema of the mucosa with an infiltration of round cells and increased vascularity resulting in sufficient swelling and thickening of the mucosa to cause some obstruction. Ieterson (11) states that this portion of the tube is singularly free from infection. The latter was present in but few instances out of thousands of sections of tubes studied in his laboratory.

In all the 17 cases of the present series in which both tube outlines appeared in the roentgenograms the intramural portion was seen to be clearly patent and in all but 1 a straight course was observed. Of the 13 cases in which only one tube outline was present the interstitial portion was very faint in 4 cases and probably constricted by disease which practically obliterated the lumen of the whole tube as only an irregular outline was observed when considerable pressure was used in the lipiodol injection. In 1 of these 4 cases I had an opportunity of observing the tubes. This patient who had never been operated upon before and whose tubes were sealed off by a single post partum infection was keenly desirous of improving her chances for conception. It was seen that the isthmus portion of the right tube was completely obliterated while the left isthmus was very markedly narrowed (Fig. 5). It was possible to transplant the patent ampulla of each tube into the corresponding horn of the uterus. Patency in this case was demonstrated later by peritubal neoinfusion.

In the 33 cases in which no tubes or only 1 tube appeared on the film after lipiodol injection 16 gave a history of previous abdominal operation in 6 others a dilatation and curettage had been performed at some time. In 11 cases no history of an operation was obtained. What role infection may have played in obliterating the lumen of the tubes in these cases can only be surmised. An analysis of such factors from the history presented will be taken up elsewhere. Here it is important to call attention to the fact that in the cases in which 1 or both tube stumps were present the intramural portion was demonstrable and showed a straight course indicating that the disease most probably involved the isthmus. It is a matter of conjecture in the absence of observations possible only at a laparotomy as to how many of the 17 cases in which the tubes were not removed by operation were obliterated *in toto* or along the isthmus portion alone. Further observations and a larger series of cases may settle this question. It appears from the evidence at hand that the isthmus is far more commonly diseased than the intramural portion of the fallopian tubes.

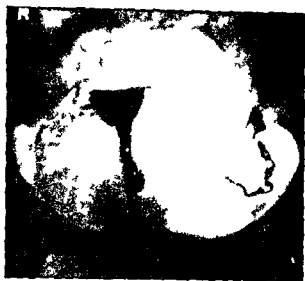


Fig. 1. Pelvic manometry of the fallopian tube. The uterus is in the center, and the fallopian tubes are on either side. The uterus is dilated, and the fallopian tubes are contracted.



Fig. 2. Roentgenogram of the female reproductive system. The uterus is in the center, and the fallopian tubes are on either side. The uterus is dilated, and the fallopian tubes are contracted.

Two factors appear to account for the relative infrequency of inflammatory obstruction in the intramural portion of the tubes (1). The scant endosalpinx with 3 or 4 fold which are relatively widely separated in contrast to the rich supply of tubal plicae of the ampulla which if inflamed become readily agglutinated and (2) the more powerful muscle of the interstitial portion would tend to expel products of inflammation when present in the direction of the wider portion of the tube or toward the uterus. In this connection it may be recalled that if inflammation of the interstitial portion of the tube were at all common the incidence of tubal pregnancy in this location would be excessive while as a matter of record interstitial tubal pregnancy is the least frequent of all ectopic pregnancies.

Narrowness of the intramural portion *per se* therefore does not appear to be a handicap from the viewpoint of procreation for which nature seems to have provided adequate safeguard. The tube moreover has the power of dilating to allow the passage of the ovum. In the pig the ovum reaches the blastula stage on the third day when it passes into the uterus. A more striking dilatation of the oviduct is seen in the hen in which a large ovum the mature hen's egg traverses the tube and uterus and passes out of the cloaca. If this be true for the

ovum it would seem at least to hold equally well for spermatozoa.

ROENTGENOLOGICAL AND FUNCTIONAL DIVISIONS OF THE TUBE

From roentgenological studies the tube may be divided into two main portions (1) a narrow proximal uterine portion and (2) a wider distal abdominal portion. The length of the fallopian tube as revealed by salpingography is greater than is apparent on inspecting it at the operating table or in anatomical examinations. In the living state it frequently measures 6 or 9 inches as against the 3 or 4 inches which it measures when removed from the body (Fig. 1). This extended length of the tubes in the roentgen films may be due to a stretching out of the tube between the force of the injected fluid. Magnification of the picture on the film is very slight.

The narrow portion or oviduct proper has almost the same caliber from its beginning just outside of the uterus to about half its entire length where the wider portion abruptly begins. The narrow portion is only slightly



FIG. 3. Roentgen gram showing a thimble portion of a fallopian tube completely obliterated. Left isthmus markedly narrowed therefore not appearing on the film.



FIG. 4. Roentgen gram showing absence of a thimble shadow on the left side. Same case as illustrated in Figure 1 in which the entire fallopian tube is beautifully shown (crerioent film).

narrower as it passes through the uterine wall where its mucous membrane is thrown into primitive folds which have a trifol or clover leaf shape to a star or H shape on cross section. This portion outside of the uterine wall is palpable as a whip cord between the fingers the sensation imparted being due to the presence of reinforced circular muscle. Unfamiliarity with this anatomical fact has led to misinterpretations and to useless operations. Kennedy (6) believed he was dealing with closed tubes in one case because the isthmus felt as though it contained a fibrous core on both sides. It was decided that they were the seat of obstruction. They were excised and a hysterosalpingo anastomosis was done which rendered the tubes patent and relieved the dysmenorrhœa but not the sterility. Carbon dioxide insufflation by Aldridge had previously shown these tubes to be normally patent. Serial section of the excised isthmus showed them to be normal.

The wider portion or receptaculum ovuli feels much softer between the fingers and begins about at or near the middle of the tube. It is provided with numerous mucus folds which lie almost contiguous and present on cross section a labyrinthian appearance. The abdominal end opens up in a somewhat constricted lumen from which radiate the fimbria. This however will for example permit the passage of a uterine cannula in contrast to a fine filiform bougie which can scarcely be introduced into the intramural portion. In the

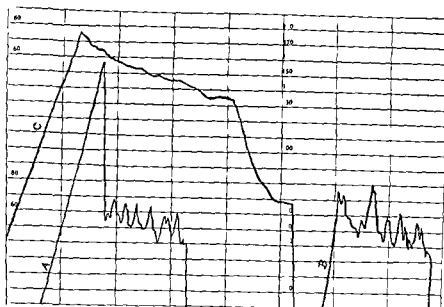
lower animals as the pig the fimbria ovarica is thinned out and broadened into an enveloping membrane which covers the ovary almost completely thus securing a more successful reception of the ovum as it is cast off and by peristalsis pushed well on through the ampullary portion. The outer end of the tube has been termed the pars fimbriata and the uterine end the pars uterina.

THE QUESTION OF ISTHMOFASMS

The difference in anatomical structure between these 2 portions is parallel with their physiological difference. If the tubes of the pig are observed in peristalsis it will be noted that the narrow portion which is nearer the uterus undergoes more pronounced contractions than the outer end.

In the presence of a foreign body such as lipiodol the human fallopian tubes may be seen to undergo peristalsis beginning at the ampullary portion and traveling toward the uterus. Reversed peristalsis is not uncommon. The contractions appear to be more powerful at the isthmus portion. The narrow portion is not so easily visible under the fluoroscope as it has the width approximately of a coarse hair. That accounts for its apparent absence in some cases. Kennedy (7) found this absence of isthmus shadows in 38.3 per cent of the tubes he examined with sodium bromide solution and the X rays. He therefore concluded

Inasmuch as the ampulla of the tube ren-



Ti A Kym r ph d f a f p a m t t h t b t j c t n
 Not th h rp t 55 mill m t m ry d th h rp d p t 5 mill m t
 r u ft h l th kym gr ph r e n mal as an b mp d w th
 n B B kym ph c t a n mal tub l pat v Int l p u t 5
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dered a shadow it must be connected with the uterus by a patent isthmus even though the passage between contains no sodium bromide. A second case of an isthmus of the tube removed by Kennedy led him to believe that a tubal isthmus appearing microscopically normal can have a patent canal and yet be obstructed. Doubtless more such tubes exist and the isthmus while anatomically normal has a physiological abnormality of the hypertonic circular muscles. In his conclusion Kennedy states: "A tube having an apparently normal ampulla and no evident abnormality of the isthmus even though it obstructs the passage of carbon dioxide gas by insufflation should not be removed at operation because we may render a patient permanently sterile who is now only temporarily so." Therefore Kennedy concludes that the isthmus must have been in spasm.

In a recent study in which the question of isthmospasm was considered it was seen that Kennedy's conclusions were based upon observations which were misleading because of technical difficulties only recently overcome. These may be briefly stated:

1. The isthmic portion of the tube is exceedingly narrow as has been pointed out

Unless a very opaque substance is used the shadow graph may not be intense enough to be seen. Sodium bromide is much less dense than lipiodol for example. Lipiodol is denser than bone shadow but the latter obscures sodium bromide especially when it overlaps a fine line such as the isthmic lumen.

2. I. Kok (5) claims that sodium bromide proves irritant to the pelvic peritoneum. Dyroff and Schober also maintain that it irritates the tubal and uterine mucosa, therefore inciting more violent muscular contraction than are provoked by substance such as lipiodol. In one instance ulceration of the bladder has been reported (Kok).

3. Blurring of the isthmus is easily produced when the patient moves or does not hold her breath. Immobility is essential. The intra uterine injection of the fluid should be made with the patient lying on the X-ray table. The focusing of the visual field is very important. Fluoroscopic visualization is of great help in getting the proper focus and condensing the field to be X-rayed. In this procedure a well trained radiologist should be associated with the gynecologist.

My study was greatly facilitated by the cooperation of A. J. Bendick (6 and 7). We

found that the isthmus was demonstrated in every instance in which the tube had not been previously removed by operation or was not obliterated by disease. In one instance the isthmus was seen by the fluoroscope but not on the X-ray film. This meant that the lipiodol had been discharged imply into the abdominal end of the tube or back into the uterus and out. The fluid is not only rapidly emptied from the isthmus but as its lumen is very narrow at best too little is left to render a contrast shadow. If serial roentgenograms are made it will be found that the isthmus will appear on the X-ray plate at one moment and not at another. This does not however indicate isthmospasm in the sense that pyloric spasm for example is generally understood. It is simply the contraction phase of normal peristalsis (Fig. 4).

Arnstam and Reinberg brought this out (12) in a recent serial roentgenologic study of the uterus and tubes with the aid of lipiodol (metrosalpingography). If intra uterine pressure with the fluid is maintained the isthmus will be seen each time because peristalsis is paralyzed by the distending fluid. When the pressure is slight or even moderate peristalsis returns and the isthmus as well as the ampulla exhibit contractions. Because of its narrow lumen the isthmus will not cast a shadow on the film unless a very densely opaque substance is used and the exposure is taken in the dilating phase. Its lumen on the other hand is wider at times than at others showing that it is capable of dilatation. If the patient is examined with the fluoroscope a few hours after the initial lipiodol injection it will be seen that the closed ampulla is filled while the isthmus is empty. The ampulla remains filled with lipiodol for weeks and months the fluid accommodating itself to the more dilated portion of the tube where it rests because of weak or totally absent peristalsis.

That there may be an augmented tonicity of the isthmus tube as well as of the whole tube may be readily granted. In studying tubal patency by means of peruterine insufflation and the kymograph it has been seen that sometimes the intral pressure required to overcome the resistance at the uterotubal junction and the isthmus resistance may be as high as



Fig. 4. Isthmogram showing gap in tubo uterine junction at the isthmus (contraction). Contrast the isthmus in left horn of the tubo uterine junction.

100 millimeters mercury. Once this has been overcome the flow of the gas is free and there is a steady drop as the undulations appear on the recording drum and in the manometer (Fig. 5 a). This occurs in a small proportion of the cases examined. Contractions of the tube vary in strength between 5 and 30 or 40 millimeters mercury. Exceptionally the manometer fluctuates between 10 and 90 millimeters mercury. Fluctuations are noted on the drum soon after the gas passes the uterotubal junction and are recorded in practically every normal case. The presence of manometric fluctuations distinguishes the normal tube in hypertonicity from a strictured tube or one which is diseased and bound down by adhesions. In the latter case if the tube is not absolutely occluded the gas may succeed in passing at a high pressure and after a drop find a level at which it continues to flow as long as the gas pressure is maintained. But there will be a complete absence of fluctuations in the manometer and of corresponding undulations on the kymograph (Fig. 5 c).

THE FREQUENCY OF INCIDENCE OF TUBAL SPASM AS A CLINICAL ENTITY

Observations of many cases in which the question of tubal patency was determined indicate that the incidence of tubo uterine spasm is not very frequent. It occurred about

9 times out of 450 cases in which the examination was made with a kymographic attachment. That is the tubes were found to be patent after an initial high pressure (150-190 millimeters mercury) was required to force the gas through them. It has been pointed out elsewhere (15) that in the premenstrual and menstrual stages of the ovulation cycle higher pressures were necessary than in the post menstrual phase. Ferdinand C. Lee (9 and 10) showed that in some of the laboratory animals it was always easy to inject from tube to uterus whereas when an injection was made in the reverse direction—from uterus to tube—the injection mass would pass with much greater pressure through the tubo uterine junction. But when the animal was found to be near the time of ovulation the injection mass would pass more readily requiring less pressure. The tubo uterine junction is apparently guarded by a sphincter apparatus analogous to the pyloric sphincter although as in the latter no definite muscle bundles have so far been demonstrated (Fig. 6). Personal experiment with gas insufflation in the living animal and upon surviving extirpated specimens of intact uterus and tubes point to a definite very small zone corresponding to the intramural portion of the tube which is capable of contracting and dilating like a true sphincter. Peinberg and Arnstam have described it and recently Schmidt and Eisler have independently raised the question as to whether there is a sphincter apparatus at the tubo uterine junction (18). The present series of lipiodol studies corroborates their findings. (This will be taken up in the near future.)

CONCLUSIONS

The intramural portion of the fallopian tube in the living pursues a straight course contrary to what is found in the anatomical specimens. It is capable like the rest of the tube of contracting and dilating. Total obliteration of its lumen is very infrequent and when present is part of more extensive tubal disease. Isthmospasm as an entity has not been definitely demonstrated but tubal contractions can be seen with the aid of intra uterine lipiodol injection and the fluoroscope. The uterotubal junction (intramural portion) appears to be

the site of predilection of spasm or hypertonicity in a relatively small proportion of the cases examined. It was demonstrated by uterotubal insufflation with the aid of the kymograph in per cent of 450 cases of sterility. It can also be demonstrated by fluoroscope and X ray film aided by lipiodol and manometric control. A sphincteric action at the tubo uterine junction has been evidenced in clinical and experimental observations.

CLINICAL SURGERY

FROM THE LEISIN INSTITUTE OF HELIOTHERAPY

HELIOOTHERAPY IN HIP JOINT TUBERCULOSIS

BY A. ROLLHEIM, MD. LITH. IN SWITZERLAND

D. t. d. Ét. bl. m. t. H. l. th. p. q. d. L. La. t. l. l. a. d. m. d. M. l. d. P.

THE cures obtainable by heliotherapy are distinguished by three principal characteristics: a splendid general condition, development of the musculature and frequent return of function in diseased joints. This last result is of particular interest in tuberculous hip disease, and for this reason we shall devote our main attention to this form.

Believing that in tuberculosis the question of the oil is of capital importance while the bacillus plays a secondary role we have recommended from the beginning of our work general heliotherapy, that is to say the methodical insolation of the total surface of the integuments. We have also arrived at this conclusion because we believe that the skin in not only an organ of protection but also a very important organ of defense. It plays a leading role in the general metabolism and is able to subserve its physiological functions only when placed in direct contact with its natural milieu: air and sun.

Proceeding from these principles we have applied since 1903 general heliotherapy to so called surgical tuberculosis and we have sought to build up a real therapeutic system based on a precise posology and associated with a rational orthopedic technique which broke with the traditions hitherto accepted. Heliotherapy of this kind in association with the air bath for which the altitude is particularly suitable stimulates admirably the natural defenses of the organism and brings about its complete reconstitution while at the same time providing the ideal local treatment thanks to the analgesic, resorptive and sclerosing properties of the solar radiations.

The action of the sun is first of all general and manifests itself on all the systems: the skin, the musculature, the blood, the endocrine organs and the skeleton itself.

The skin when placed in contact with the air and sun is toned up and pigmented; it regains its

many physiological functions and becomes once more the real garment provided by nature. Thanks to the fine mesh of capillaries alternately dilating and contracting it forms by this expansion of the vascular system a peripheral heart. Through its multiple nerve endings for touch and pain it also becomes another expansion of the nervous system. The skin is also the vicar of the kidney, secreting as it does more than one liter of sweat per day with sebaceous matter and various toxic substances. It is furthermore the most important source of immune bodies, probably also the most important endocrine organ.

Skin when pigmented and thus physiologically adapted to heat and cold resists the penetration of germs; the cicatrization of wounds is thus favored and such a skin is refractory to many cutaneous affections. The pigment serves not only as a protection against over irritation by the ultra violet rays but also as a regulator of the sun's heating power. It probably plays an even more important part; it is supposed that it acts as a kind of accumulator of dynamic forces and our experience tends to confirm this view inasmuch as a patient's resistance is generally proportionate to his pigmentation. It becomes indeed increasingly evident that the skin receives, furnishes and activates the essential elements for the metabolism of hormones and vitamins and it is probable that the majority of the avitaminic conditions are simply due to lack of sun.

The action of the sun on the musculature is very remarkable. By dilating the skin capillaries it causes a flow of blood from the depths to the surface, thus acting as the most perfect massage. The building up of the muscles under the influence of the sun may be attributed doubtless to this more active circulation and also to the continuous reflex tonic action on the muscular fiber arising from the vibratory shock of the radiations on the mesh of sensitive nerve endings in the skin.

By restoring to the muscles and ligaments their natural tone the sun cure re-establishes the normal balance of this lever mechanism and thus by an eminently physiological process brings about the return of articular function.

The sun's action is exercised not only on the muscles but on the bones. We have about 50,000 X-ray plates which prove beyond question that no lesion however deeply situated remains insensible to the solar radiations. The first sign of cure in bony lesions is recalcification, but this recalcification of the bony skeleton is not peculiar to tuberculosis; it is a commonplace in the treatment of rickets and of other bony dystrophies. We drew attention to this property from the beginning of our work in 1903, and the question has of late years been studied by many authors particularly Hess of New York and his collaborators Paffenheimer and Ungern, who have demonstrated an increase in the calcium and phosphorus of the blood under the action of light. This remineralization of the organism is contemporaneous with a steady increase in the percentage of hemoglobin and of the number of red blood corpuscles. Further the sun cure, especially in mountain air, causes an increased respiratory activity which improves the heart action and the general circulation. The metabolism is increased, the appetite awakened, the digestive functions invigorated and the strength is recovered. Finally heliotherapy has a favorable action on the internal secretions due to the stimulation of the endocrine glands by the solar radiations.

While then general heliotherapy can restore to the body undermined by tuberculosis a normal physiological function and a symmetrical harmony, its local action is of equal importance in the treatment of bone tuberculosis and particularly in hip disease. The solar radiations are analgesic; pain rapidly diminishes and finally disappears under their influence combined with that of a suitable extension. The resorptive power is shown by the fact that periarticular edema and infiltration steadily decrease and finally their cicatricial action is proved by the recalcification of bone evident on the X-ray film. The sun has also a valuable cleansing action on sinuses and by its bactericidal action rapidly heal the most obstinate and chronic wound. It is of fundamental importance to remember that heliotherapy will not give such valuable results if it is used haphazard.

A rigorous dosage and strict technique are primary essentials. We have established certain principles of dosology applicable to all cases which are of such importance that I feel compelled

to state them briefly. Dosage must be so graduated that the reactions produced by the solar radiations in the organism are never of harmful intensity. This requires of the doctor an active control and a strict individualization (careful examination of each case on arrival, slow gradual adaptation first to the open air and then to the sun, careful study of the general and local reactions which may occur during treatment and which are for the doctor the most valuable indications for the further progression of insolation, etc.).

On arrival a case of hip disease is immediately relieved of his plaster apparatus. After a few days of repose and acclimatization immobilization and extension are begun. In some cases extension must be applied immediately after removal of the plaster to combat pain and tend not to dislocation. The patient remains at first in his room with the windows open where he accustoms himself gradually to the altitude. Then if he shows no general reaction attributable to climatic condition (e.g. rapid pulse, subfebrile temperature, nervous excitability, etc.), his bed is rolled out on the balcony to accustom him to the open air. After a period (which depends for its length entirely on the observations of the doctor (general resistance of the patient, state of his organs, presence or absence of secondary infection with or without elevation of temperature, etc.)) the sun cure proper can be started.

The reaction of the organism to the sun, both local and general, varies with each patient and it is essential to regulate the sun bath according to the individual indications. The optimum duration of insolation in each case is easily determined by careful observation. We have nevertheless drawn up a simple schema to serve as a general guide. The main principle is in every case to start with the lower limbs. This is an obviously rational precaution for by exposing first the legs and feet a neutral reaction which can be insolated without danger one can measure the degree of the patient's tolerance of the sun and thus acquire at the start valuable indications for the continuation of treatment. This method by causing a flow of blood to the lower limbs has a marked decongestive action on the thoracic and abdominal viscera. Our long experience has taught us that by the correct use of heliotherapy as above described even in the most advanced case, run risk of accidents.

The first exposure to the sun is therefore very brief. On the first day the feet are exposed 3 times for a period of 5 minutes each with a half hour interval between exposures. On the second day the feet are given 3 periods of 10 minutes each and



Fig. 1. Patient suffering from tuberculous arthritis of the hip joint, in the process of extension and flexion, with the work of the apparatus.

the legs 3 times of 3 minutes up to the knee. The following day 3 times of 15 minutes for the feet 3 times of 10 minutes up to the knee and 3 times of 5 minutes to the hips. On the fourth day the abdomen is exposed to the sun and the fifth day the thorax with a damp cloth protecting the precardial region. The upper regions of the body should be exposed with great prudence. During this time the condition of the patient, his temperature, pulse and particularly the local reactions are carefully observed and at the least sign of intolerance the periods of insolation are shortened or momentarily suspended. This schema is of course susceptible of variation in accordance with the patient's degree of resistance, his sensitiveness or nervous temperament. It is essential to individualize and vary one's methods for each case if good pigmentation is to be obtained in the minimal time without accidents. Insolation of uninfected tuberculous hip joints for instance demands a quite different procedure than do those cases in which infected abscesses (not cold abscesses) and sinuses are present. In the latter type local reactions are common with rise of temperature and abundant suppuration; such reactions are often injurious when they are too acute and they must be kept within bounds or in some cases completely avoided. This demands careful individualization guided by an instinct which is only acquired through experience. When

the body starts to pigment insolation of each region may be doubled and the patients exposed to the sun for several hours. Experience has however proved that it is useless and sometimes dangerous to prolong the sun bath immoderately, generally speaking 4 hours a day is a reasonable average. During hot weather the sun should be taken in the early morning hours to avoid overheating, which both constricts and exhausts the organism.

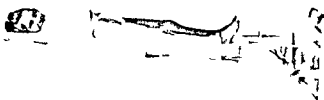
Ichthyotherapy alone cannot of course bring about the cure of hip disease with correction of orthopedic deformity. Rational orthopedics must be used as an adjunct. The following principles form the basis of our orthopedic practice. In the first place we have broken with the old tradition of which the main dogma was the closed plaster apparatus. From the beginning of our work we considered the wearing of such apparatus to be in contradiction with true physiology and orthopedics. These impermeable shells by depriving the diseased region of air and sun destroy the local resistance at the very place where it is most needed. Their use causes rapid atrophy of the integuments, atrophy of the musculature which is indispensable for the return of articular function and atrophy of the bony skeleton inasmuch as decalcification of bone is favored by lack of sun accentuated in this case by the toxic decalcification of tuberculosis. We have replaced the fixed



C



B



D

I l t h t b
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t h t b u l a r t r u t r f r m f r m b b t n

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a t t t d M d f t D S m p t t t
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f t y a

plaster shell by orthopedic appliances of great simplicity of which the main principle is the free access of sun to the diseased regions thus aiding the local defense without hampering the general treatment

For hip disease just as for Pott's disease the correct arrangement of the bed is the touch stone of orthopedic treatment. The mattress should be flat and of hard material sufficiently resistant to avoid forming hollows under the pressure of the body as a soft mattress into which the body sinks prevents normal evaporation of sweat favors the maceration of the skin and the formation of bed sores it may also cause faulty position.

The bed we use is of metal with an under frame of steel plates. It is furnished with wheel to allow of its being rolled on to the gallery and is sufficiently high to facilitate the careful control of the position of the pelvis and the extension apparatus and at the same time permit of free exposure to the sun. A millet seed cushion is placed on the hard mattress to raise the pelvis a very important

point in the treatment. This raised position while steadying the pelvis facilitates perfect exposure to the sun of the coxofemoral region it is further largely instrumental in preventing flexion and adduction deformities or in correcting them if already present on arrival. Continuous extension of the leg on the diseased side is an absolute rule of treatment. Its object is to hold apart by axial traction the articular surfaces so as to prevent friction and adhesion with contact contamination of the opposite surface. By this separation of the articular surfaces it helps the analgesic action of the sun. The extension should pull from the thigh to avoid distension of the knee joint. Formerly we used manchettes or cuffs made of leather attached one above the knee and one at the ankle and joined by leather straps to which the extension weights were slung. These cuffs however were found to have a slight tendency to atrophy the muscle and we have now replaced them with long strips of sticking plaster reaching up to the trochanter

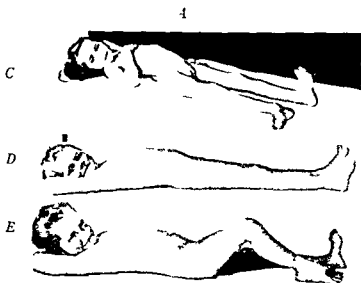
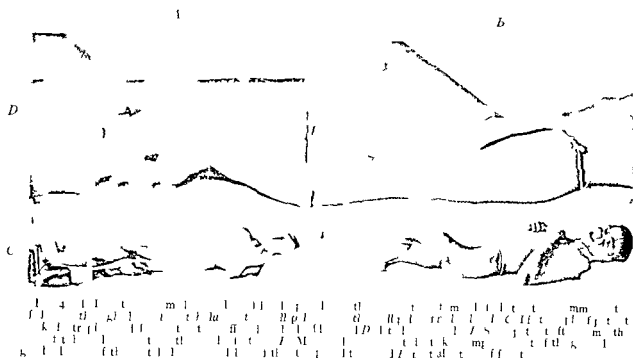


FIG. 3. 1. Roentgenogram of patient of 6 years with marked adancel tuberculous coitis showing flexion and neck luxation and dislocation. 2. Roentgenogram showing patient with slight incurvation of the neck. 3. Roentgenogram of bony structure showing a tuberculum interperfectum. 4. Photograph showing faulty position with external rotation, general atrophy of muscle. 5. Same patient after 1 year showing position of correction of the muscle and improvement of general nutrition. 6. Same patient showing return of articular function.

To facilitate the extension and to get the full unhindered pull of the weight applied we use a back splint of aluminium or perforated celluloid on which the leg rests. This is posed on a fixed static and is fitted with small wheels which run in grooves. We thus avoid the friction of the heel on the bed and the extension loses none of its force. When the pelvis is tilted extension is applied to the other leg thus re-establishing the equilibrium. Where combined abduction and extension is required we use an apparatus in which the aluminium back splint with its static is in turn posed on another static on which it is freely movable in a lateral direction. By applying a lateral weight extension to the back splint abduction is thus combined with extension. In some cases in which deviation is very marked a rubber tube padded with gauze is passed through

the opposite groin and the two ends fixed to a pulley extension at the top corner of the bed.

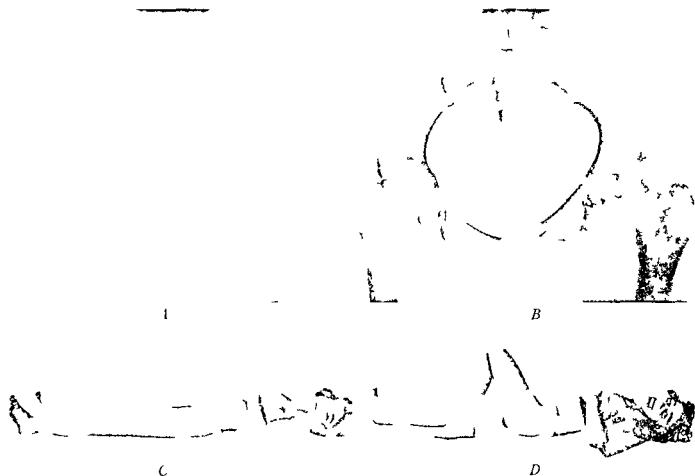
In many cases of hip disease the malposition of the hip joint is accompanied by a tendency to equinism of the foot. To combat this we use a special sandal with a wide sole which is fixed over the instep two elastic bands running from the toe of the sandal to above the knee are put more or less on the stretch according to the degree of equinism. This apparatus in no way interferes with the mobility of the foot which it gradually brings back to correct position. For children and restless adults it is advisable to apply a thoracic brace of strong canvas which acts as a counter extension and insures a more complete immobilization. It is fitted with shoulder straps and buckles. This brace which can easily be opened to allow of general insolation is firmly fixed to the



be! It is applied as a general rule to all children suffering from hip disease. If it is considered necessary the pelvis can be more securely immobilized and at the same time undue pressure on the abdomen avoided by means of a simple friction elastic band passed round the hip and fixed at the side. Straps furnished with buckles thus banish the two sides of the bed and thus assure a comfortable position and satisfactory equilibrium of the pelvis.

One of the first results of the treatment was associated with a rational orthopedic technique, the disappearance of pain which marked it off after a short time. Even after the first day the

it is well known that the treatment is very near normal. This analgesic action must be attributed to the direct action of the treatment on the deeper regions of the body. I have seen it very often in the treatment of the general condition of the nervous system and in the whole organic system, and the influence of the treatment bath will contribute largely to the diminution of pain. One must never forget that the patient must be in a position to rest in the treatment. It is fully stimulated by the marvellous action of well known high hydrotherapy in the treatment of the bath for the treatment. We are often the factor of a real



Fi 1 I nt, on ram t i m i r t i n f t l
tal ulum c n t u r f t h l l i n l f t l t a l h
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nu l l i u p i n o f t r a l u l a r t r u t u r e c o m p l e t e
l m r a t i n i n t r a t u l a r p a l u r r C l l t g r a p h
t i t i t D N o r m a l f u n t i o n f r o m n t h s

psychical renaissance in our case of surgical tuberculosis and among them the sufferers from hip disease. This reaction certainly hastens the progress of the cure and forms a valuable aid for the doctor who must in all such chronic troubles combine a knowledge of psychotherapeutics with his other attainments.

Another precious aid for the morale of the patients is the work cure which can be practiced regardless of the weather and which experience has taught us to value as a real therapeutic agent. In the profound conviction that rigorous and complete immobilization is an error prejudicial to the organic defenses we sought by introducing a progressive course of manual work, strictly individualized to develop the specific resistance of each patient contemporaneously with his general resistance.

It may seem somewhat paradoxical at the first glance to propose manual work for cases of surgical tuberculosis often seriously ill and always confined to bed. Our experience however has been that graduated regular work under medical control has never in the least hindered the prog-

ress of the cure. On the contrary it is a real help for cases of hip disease. A special apparatus enables the patients to work lying on the back without any danger of the least unsuitable movement of the hip joint which is held by the running extension. They can thus easily learn weaving, knit, crochet, painting on wood or on porcelain while patients with Iott's disease in the ventral position are able to undertake wood cutting, box and basket making, typewriting and the manufacture of minor mechanical objects. The advantages of this work cure when carried out systematically are indisputable: it is the most powerful antagonist of boredom—the common danger in all chronic diseases and it provides poorer patients with an appreciable financial aid. A tuberculous subject once capable of undertaking remunerative work loses the depressing feeling of uselessness regains a sense of his social worth and thus enters on the first stage of his return to normal life.

As soon as the clinical and radiological condition of the hip joints permits of moderate mobilization without fear of accident the patients are

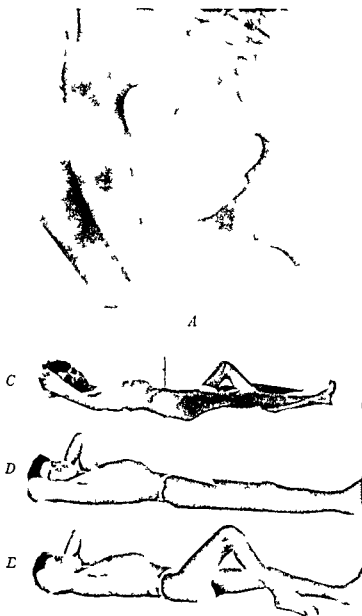


FIG. 7. 1 Roentgenogram of patient with tuberculous coxitis showing luxation after migration of the acetabulum head of femur completely displaced forms indefinite cloudy mass B Roentgenogram showing readaptation of head to the displaced acetabulum which is firmly sclerotized cicatrization of head satisfactory function C Photograph of patient showing vicious attitude cachexia of course neglected D Cured after 2 years E Complete return of function

already pointed out is quite common in the cure of hip disease by heliotherapy. It is however always spontaneous we never allow active movement of the joint by the patient nor do we ever attempt passive movements. To nature belongs the task of restoring function so far as she judges it possible and free from danger. The beginnings of movement are seen during treatment and develop *pari passu* with the progress of cure. But only after the X ray has demonstrated the cicatrization of the bone do we allow the patient to try occasional flexion movements which improve the circulation and strengthen the muscles. By daily repetition of these small flexion movements one helps the restoration of mobility to the joint in so far as the anatomical condition permits.

I must admit that in the early years at Leysin impregnated with the teaching of my master

Professor Koch of Berne whose assistant I had the honor of being for 4 years I was surprised and somewhat disturbed to see return of function following cure by heliotherapy. I was however reassured by the examination of X ray films showing a magnificent bony reconstitution of the affected articulations and later we were able to convince ourselves that hip disease cured by heliotherapy with recovered movement had much less tendency to relapse than when cured with ankylosis. In the beginning this return of mobility seemed to us so abnormal and uncertain that we thought it necessary to fix the healed joint with an unjointed celluloid apparatus. This we soon abandoned realizing on the one hand that the apparatus tended to atrophy the fine musculature of our hip cases and on the other hand that the return of function was both solid and durable. One must attribute this mobility to a combination of the following factors: the improvement of the circulation and of the local defense under the action of the sun the building up of the musculature which is stimulated to more active metabolism by the actinic rays and which thus reacts much more easily on the bony levers as soon as the joint is capable of movement and finally to our system of orthopedics which by condemning



A



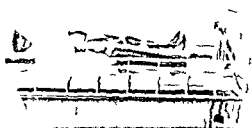
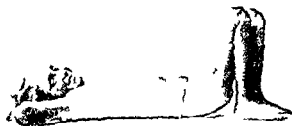
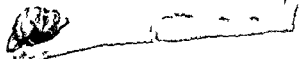
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E



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place in the ventral position for a part of the
un bath. A wedge-shaped cushion is placed under
the thorax and another under the feet to avoid
excessive traction on the toes. The ventral po-
sition does not exclude the maintenance of exten-
sion and it has the great advantage of allowing
exposure of the whole body to the sun particu-
larly the thigh regions and thus helping the
development of the musculature. Often a real
muscular regeneration is the result. The quadri-

ceps often degenerated to mere strips and the
gluteal mass completely flattened out inelastic
and befit of all power remain a form and size
approaching the normal. As the circulation be-
comes more active and intense under the action
of the sun and with the renewed participation
of the integuments in the circle of local me-
tabolism so the muscles recover their tone and
elasticity and contribute to the return of articular
function. The return of function as we have

A

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In 9. 1. 10. itgen ram of f r t n t i t h r t u l r
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t r n t h n d u n d a t r i e d a n l r r a p t d t o a l m t n o r
 m l f u n t i o n i t h a t r o b o n y p a r t i t i o n a s p i n t
 d p p C n l l D C n l i t o n o f p a t i n t n a r r i u l f a n d l
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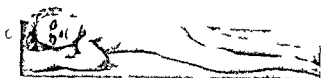
as it is often the case by a pus debile recovery
 is rapid This is however not so when the pus is
 incompletely evacuated and remaining in the
 tissues causes serious intoxication which may
 ultimately lead to amyloid degeneration To
 prevent an inopportune closure of the sinus
 openings with the danger of retention the sun is
 applied in small doses and damp compresses are
 afterward laid on In the sinuses with a deep
 track a wick of sterile gauze is inserted or lam-
 inaires to prevent premature closure Generally
 the sun by virtue of its strongly detergent and
 eliminative action tends at first to increase sup-
 puration It then diminishes becomes sero

purulent serous and finally dries up altogether
 when the general and local condition is sufficient-
 ly restored In some serious cases of fistulous hip
 disease with multiple sinuses and deep abscesses
 the procedure indicated is not sufficient to pre-
 vent retention inasmuch as the horizontal po-
 sition impedes the drainage through openings
 situated in front or often even in the iliac fossa
 To facilitate drainage in such exceptional cases
 only we feel justified in allowing the patients to
 get up before complete cure of the bony lesion
 and we permit them a little graduated exercise
 on crutches In such cases the bad leg hangs
 freely without the aid of any supporting appa-



B

F S 4 R t m f p t t th b l t l
t b l t t n t l u t h c t l t
t l l t n d p f t f t h t l l m
P (t l h t d p l t d l l t
t h t b m l y t i n d l g l t u t C
l h t ph t D P t t l f t m th
E l h to l l t t f f t



the plaster cast eliminated straight off the principal cause of functional impotence. In addition heliotherapy by diminishing the frequency of abscesses and their complication the secondary inflammatory reactions e.g. edema sclerosis and thickening of the soft parts vascular atrophy etc. provide a further aid to the return of articular function. Treatment of hip disease by heliotherapy is most successful when the lesion is a closed one. In the presence of a cold abscess contrary to the generally accepted practice we are in no hurry to aspirate. We wait as long as possible i.e. as long as the abscess does not

threaten to open spontaneously. Aspiration is carried out when the skin thins locally by the abscess demonstrates that nature has no further use for it and is seeking to get rid of it. We attach great importance to the presence of the cold abscesses which by their content in immune bodies contribute a valuable immunizing factor to the defense of the organism. Aspiration is carried out at a distance and is repeated if necessary to prevent spontaneous opening. Experience has taught us that the complication of mixed infection is completely reverse the favorable prognosis of the hip disease. And for this reason we insist on conservative treatment of this condition which avoids trunnings, a common orthopedic rule.

In the tuberculous hip disease the essential indication for urethral drainage is the drainage of the infected area. If the drainage is well drained the infection is improved with the improvement of the general condition. If on the other hand drainage is insufficient period of retention are frequently accompanied by high temperature and irritant excretion and pain all of which have their effect on the general health. When the attacks are followed

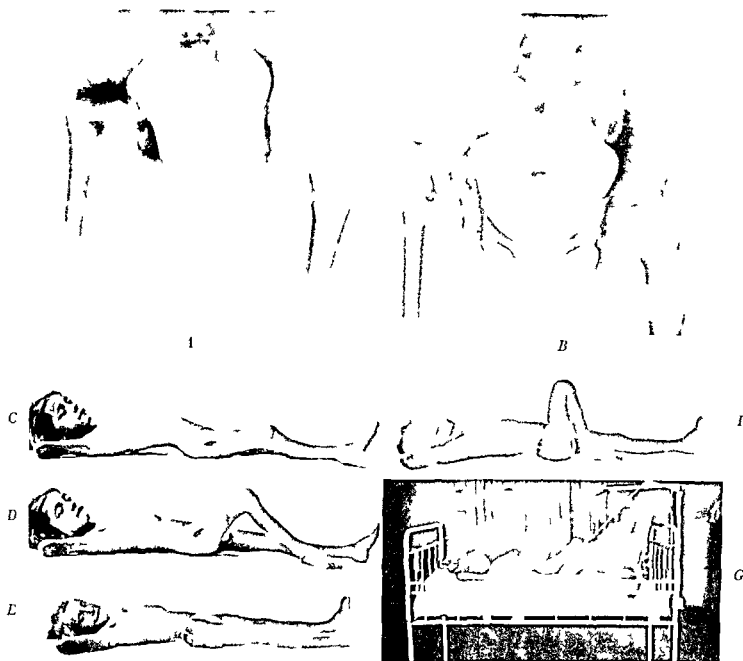


FIG. 11. A Roentgenogram of patient with a tuberculous cavity showing luxation after destruction and loss of head and neck. The whole joint is damaged and shows no clear structure. B Partial correction of the vicious attitude. Solid reparation of the floor of the acetabulum. C General calcification. D Photograph of patient showing general condition. E Photograph of patient after 5 months. F Photograph of patient showing the turn of articular function. G Photograph of the apparatus of extension on an inclined plane.

struction by stages a strong partition of rough structure is first laid down which then becomes compact and regular a new articular cavity is formed firm and delimited allowing a functional adaptation of the new femoral head to an often unhelped for degree. Once the bony cicatrization is complete clinically and radiologically the period of training for the vertical position and for exercise begins. Prudent graduation is naturally essential with the ordinary precautions. The legs are bandaged with elastic bandages to prevent

abrupt dilatation of the venous network. Orthopedic insoles are placed in the shoes to support the plantar arch and avoid flatfoot etc. As regards the celluloid apparatus which we formerly used to support the hip joint experience has gradually led us to abandon it in most cases. Cases of hip joint tuberculosis cured by heliotherapy are generally provided with such a solid muscle scaffolding that a supporting apparatus is quite superfluous. The patient should not use crutches when beginning to walk as they have a

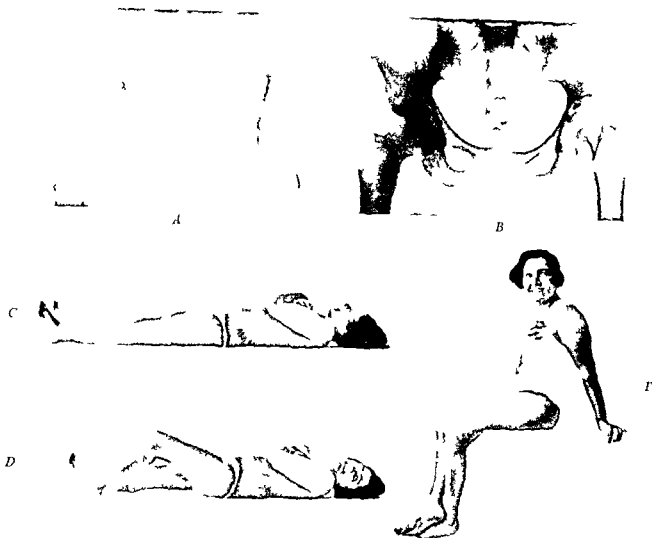


FIG. 1. A. Röntgenogram of patient with tubercular hip joint. B. Patient in bed. C. Patient in bed. D. Patient in bed. E. Patient in bed. F. Patient in bed.

FIG. 1. A. Röntgenogram of patient with tubercular hip joint. B. Patient in bed. C. Patient in bed. D. Patient in bed. E. Patient in bed. F. Patient in bed.

tus which might cause pain or impede the circulation and the sound foot is raised in an orthopedic boot. We have often succeeded by this change in facilitating the evacuation of pus recovery from intoxication return to a regular temperature curve and consecutive improvement of the general and local condition. As a general rule we do not allow our cases of hip disease up until X-ray examination confirming clinical findings has demonstrated complete sclerosis of the lesions.

Some 50,000 X-ray films have been taken here since the beginning of our work and we have had ample opportunity to observe that no bony lesion however deep escapes the influence of the solar

rays. In hip disease bony reparation and reconstitution occur in the following way. We commonly see tuberculous cases in full activity with the acetabulum the head and even the neck of the femur showing the signs of extensive melting represented on the film by the well known fog which obliterates the contours of the joint. In this chaos a new head gradually reappears of which the outlines at first confused and cloudy become gradually more precise and regular. The demarcation zone becomes clearer and the calcified regions are the seat of intense recalcification. In other cases in which the femoral head had burst through the caseating floor of the acetabulum the X-ray films demonstrate recon-

FROM THE DIVISION OF SURGICAL MEDICINE

TECHNIQUE OF REMOVAL OF CYSTS AND SINUSES OF THE THYROID GLAND

BY WALTER SISTRUNK, M.D., F.A.C.S., CHIEF, THE MINNEAPOLIS

TO operate satisfactorily for the removal of cysts or sinus tracts of the thyroid gland a surgeon should thoroughly understand the mode of development of such cysts and possess accurate knowledge of the anatomy of the base of the tongue and surrounding structures.

Early in fetal life, before the hyoid bone develops, the thyroid gland appears at the base of the tongue and descends in the median line of the neck. In normal individuals the epithelium-lined tract produced by the descent obliterates; if obliteration fails to occur completely, the secretion produced by the epithelial tract probably empties through the foramen cecum into the mouth. Should this opening into the mouth lose its patency through inflammatory or obliterative changes, the secretion works downward along the tract through which the thyroid gland has descended and produces a cystic tumor in the median line of the neck, usually at a point about midway between the hyoid bone and the top of the thyroid cartilage. The cysts, after passing

downward below the hyoid bone, become superficial and lie beneath the raphe joining the sterno-hyoid muscles and the thyroid cartilage; they occasionally descend as low as the sternal notch but are always found lying in the median line or very close to it, thus differing from branchial cysts or sinus tracts which are always lateral to the median line.

Should a sinus tract be present, it should be injected with a weak solution of methylene blue in order to outline its course definitely. Under general anesthesia, with the patient in the usual position for performing thyroidectomy, a transverse incision 5 or 6 centimeters long is made over the cyst through the skin, subcutaneous tissue, and platysma muscle (Figs. 1 and 2). The cyst or sinus tract will be found lying under the raphe joining the sternohyoid muscles. This raphe is cut longitudinally and the cyst dissected free from its attachments up to the hyoid bone. The tract usually passes underneath the bone

Incision
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md
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Fig. 1. Cyst and tract in relation to muscles and hyoid bone. Insert shows position of head for thyroidectomy operation.

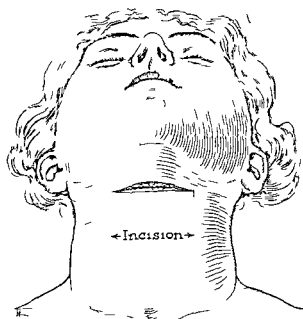


Fig. 2. Position of incision.



A

B

C

D

I t h l l t m t p t t th tul r l u t l d t l a t m tru t S t t t y l f
 t h l l p a t f t t l t r t r t l t l m l l C h t g ph f l t t u d
 t l l f t l f m Th t l lum i l d th f t t l f t t D S f t t h th t n f
 h B C u d p f t l u m f f t l f t

tendency to deform the joint and very long stick held at the shoulder level so as to extend the chest are useful in our clinic.

The results obtained by heliotherapy are I believe conclusive and a careful study of the roentgenograms will enable any one to come to the same conclusion. The results are a proof of our contention that heliotherapy may be considered as the ideal conservative treatment for tuberculous hip disease. The treatment has in addition a considerable social value. By avoiding mutilating operations and developing a

splendid musculature it retains in most cases the articular function in its integrity and gives back to the body a symmetrical harmony. To sum up it enables us to give back to society a normal being splendidly fit capable of working for their living.

N n -D t l d l l f r l f f h p f
 a t l f u d n t l e s f m l l t a t l d v d
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 l t l n n s l n y d D
 M l l a t l t l d l t d d l f t o
 t l l t h r t t l l e t t p l H l
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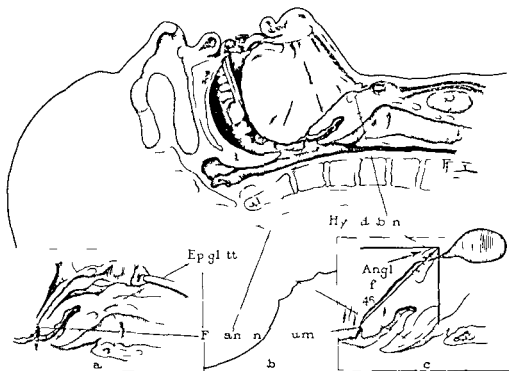


Fig 6 a Di section of tract down to mucous membrane b Position of tract c Angle of tract

but may pass superficial to it or through it. In order to remove the duct completely at this point a small segment or 3 millimeters in diameter is removed from the center of the hyoid bone. The mouth is then held open with a gag and the tongue pulled forward with a suture or small stomach forceps. The index finger of the left hand is introduced into the mouth and the foramen cæcum located by palpation (or inspection). This may be done by following the two rows of circumvallate papillæ one of which lies on each side of the tongue backward to the point where they join in the median line. The foramen cæcum lies just posterior to this point (Fig 3). This is pushed forward and upward with the finger in order to shorten the distance between it and the hyoid bone (Fig 4). Then without an attempt to isolate the duct the duct and the tissues surrounding it for a distance of about 3 millimeters on all sides are coared out through the muscles of the tongue to the mucous membrane at the foramen cæcum where they are cut off without opening the mucous membrane of the mouth (Fig 5). In doing this it is necessary to bear in mind the direction of the thyroglossal duct. With the patient in the position suggested this corresponds to a line drawn at an angle of 45 degrees backward and downward toward the foramen cæcum through the intersection of lines drawn horizontally and perpendicularly to the

center of the hyoid bone that is it corresponds to a line drawn from the center of the hyoid bone to the foramen cæcum (Fig 6).

In temporarily disregarding the duct and coring out the tissues through which it passes lies

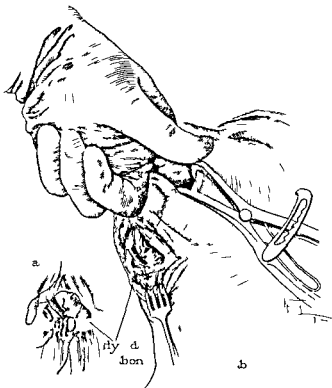
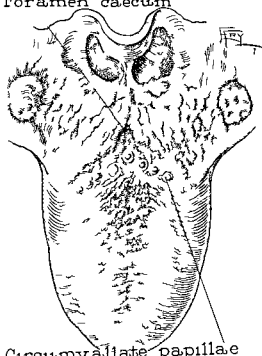


Fig 7 Suturing ends of hyoid bone together



Fig 4 I m the l t t t

Foramen caecum



l g 3 Pos tio f fo m n cæ m

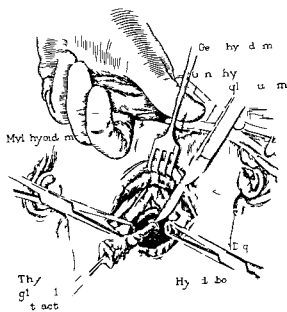


Fig 5 C t t f f d f t t

REPAIR OF INTERNAL RING IN OBLIQUE INGUINAL HERNIA

BY I. GILGOLY, CONNELL M.D. O. HROSH, M.D.

THE internal or abdominal inguinal ring is the landmark that distinguishes the two types of inguinal hernia. In the indirect or oblique the sac passes through the internal ring in the direct which is practically a ventral hernia in the inguinal region the sac passes not through but below the internal ring (Fig. 1).

With large indirect or oblique inguinal hernia the internal ring may be dilated to such a degree that its lower margin approaches the pubic arch. Under these circumstances there is still an anatomical distinction but little practical difference between oblique and direct hernia and a plastic repair similar to that for direct hernia is indicated.

The internal ring may be likened to the keystone of the arch in nature's architecture of the inguinal canal. Under normal circumstances this structure helps to prevent the protrusion of viscera through the inguinal canal. It is situated at the entrance to the inguinal canal and one may reasonably suppose that if this structure is normal in its relationships contents size and position indirect hernia would rarely develop. The size position and relations of this internal ring determine the length obliquity and character of the walls of the inguinal canal all of which are important in nature's method of preventing the development of oblique hernia.

If small the internal ring is high which means the canal is long and oblique its lower border and the posterior wall of the canal are strong firm tense composed of transversalis fascia reinforced by the ligamentum interfoveolare of Hesselbach and the anterior wall of the canal is composed of red internal oblique muscle and external oblique aponeurosis. On the other hand if the ring is large it is low and wide which

means that the canal is short and straight its lower border and the posterior wall of the canal are weak relaxed and often are absent and the anterior wall is composed of only the external oblique aponeurosis.

The relationships are shown in parallel columns as follows:

INTERNAL OR ABDOMINAL INGUINAL RING

	Normal	Abnormal (hernia)
Abdominal aspect	Smooth parietal peritoneum	Bulging parietal peritoneum hernial sac
Cutaneous aspect	Normal	Abnormal (hernia)
	Internal oblique muscle	External oblique aponeurosis (Internal oblique above internal ring and sac)
Superior margin	Transversalis fascia	Same
Inferior margin	Incrassated fascia reinforce by fold of the ligamentum interfoveolare	Same but inferior margin may be depressed to pubic bone depending upon contents of sac
Contents	Cord only or cord and preformed sac	Cord sac and contents of sac
Size and position	Small and high	Dilated and inferior margin lower

As the abnormal internal ring allows the protrusion of the sac or the filling of a preformed sac and the sudden or gradual development of a hernia the normality or abnormality of the internal abdominal ring is followed by normality or abnormality of the inguinal canal.

The normal inguinal canal is long oblique narrow and contains no sac the internal ring is high small it snugly surrounds the cord and is covered externally by the internal oblique muscle (active muscular check at entrance of canal) and the external ring is low small and triangular.

The hernial inguinal canal is short straight wide and contains the sac which often extends to the crumum the internal ring is lower dilated and is not covered externally by internal oblique muscle and the external ring is dilated upward and rounded.

The relationships are shown in parallel columns as follows:



Fig. 1. Showing an oblique and a direct hernia. 1. Oblique hernia. 2. Direct hernia. 3. Pubic arch. 4. Internal inguinal fossa. 5. External inguinal fossa. 6. Internal inguinal ring. 7. Internal inguinal ring. 8. External oblique muscle and tendons. 9. Groin of the external oblique. (From von Begegnung.)

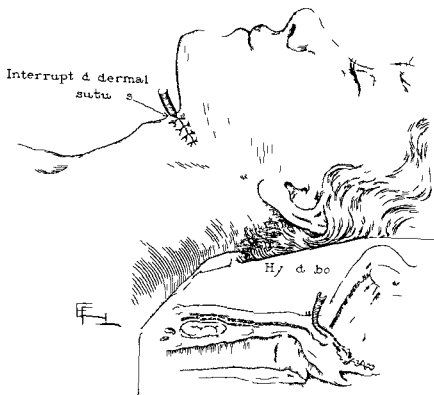


FIG. 8. W. d. l. l. th. d. t. l. l. f. t. l. l. l. g. t. l.

one of the secrets of cure, as the duct is so small and delicate that it is almost invariably broken, retracts and is lost if efforts are made to dissect it out alone. The finger in the mouth serves as an excellent guide to prevent entrance through the hyo epiglottic fold into the mouth or into the pharynx.

In dissecting out the duct a portion of the hyoid bone, portion of the raphe of the mylohyoid muscle and portion of the geniohyoid and geniohyoglossus muscles are removed.

The opening through the muscles of the tongue is closed with several interrupted catgut suture placed superficially through the muscle of the

tongue (in order to avoid the hyo epiglottic fold) and the edges of the hyoid bone are brought into apposition with one or two chromic catgut sutures taken through the periosteum of the bone and the adjacent to it cut end (Fig. 7). A small rubber tube is introduced deeply into the muscle of the tongue and is allowed to remain for 4 or 5 days. The skin wound is closed with interrupted dermal or horse hair suture (Fig. 8).

No harm has resulted from a large group of cases by removal of a small segment of the hyoid bone and following such an operation practically all patients are cured.

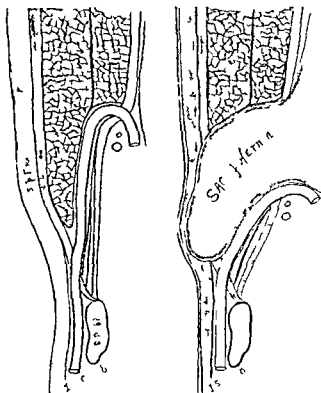


FIG. 4

FIG. 5

FIG. 4 Normal inguinal canal

FIG. 5 Abnormal inguinal canal oblique inguinal hernia

Seelig in 1923 caused considerable controversy by claiming that fascia and muscle would not unite but Koontz in 1926 was unable to confirm Seelig's findings. In 1927 Seelig in an article entitled "Fundamental Principles Underlying the Operative Cure of Inguinal Hernia" finds that fascia will unite with perimusium, perimusium and endomysium (the connective tissue covering and between the muscle) and that traumatized muscle because of the exposure of the fibrous tissue trabeculae will unite satisfactorily with tendon and aponeurosis.

After the proper reconstruction of the internal ring suture of the internal oblique muscle to Poupart's ligament is rarely indicated because the muscle will without suture cover the ring.

The normal relationship may be re established by elevation of the ring to a position behind the muscle or depression of muscle in front of the ring.

The former is much more satisfactory but if in larger hernia simple elevation of the ring is not sufficient the muscle after traumatizing may be sutured to the outer half of Poupart's ligament with reason to anticipate union.

In the direct or the large indirect hernia with relaxed abdominal walls and obliterated or absent conjoined tendons and transversalis fascia in

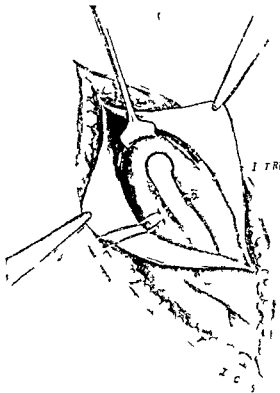


FIG. 6 Repair of internal ring (from Creory Connell 1908)

which satisfactory sutures require so much tension as to defeat their purpose a plastic operation preferably with transplantation of living tissue will be called for but such plastic operations do not change the underlying principles of the attempt made to correct the abnormal inguinal anatomy.

Koontz finds that heterogenous fascia may be used satisfactorily and such fascia is promised for the general market.

The transplantation of free flaps of fascia lata (as advocated by Kirschner 1909) has been successful in repair of hernial defects but has now been largely superseded by the modification of Gallie and Le Mesurier in which the fascia transplant is cut in narrow strips and the defect repaired by a darning or interweaving process. This gives much more marginal contact and therefore more likelihood of survival. Such transplantation of tissue is called for in large defects and often after previous attempts at cure.

The imbrication of the external oblique aponeurosis in the method of F. Wyllie Andrews is in effect a fascia transplant as is Mac Arthur's

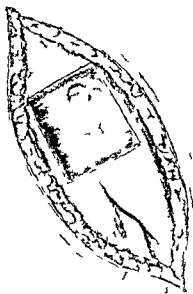


Fig. 1. Normal inguinal canal.

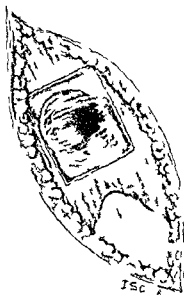


Fig. 2. Abnormal inguinal canal.

The normal inguinal canal is a triangular structure, the base of which is the external ring, and the apex is the internal ring. The canal is formed by the internal oblique muscle and the transversus abdominis muscle. The normal canal is shown in Figure 1. The abnormal canal is shown in Figure 2. The abnormal canal is characterized by a distorted shape and a distorted internal ring.

2 Reconstruction of the inguinal canal along anatomical line based upon knowledge of the normal and pathological anatomy and physiology which must of necessity vary with the type of hernia

3 Primary wound healing

The first and third seem practically easy to attain but the second is not so simple. Much consideration has been given to the wall of the canal and the external ring but the importance of the internal ring seems to have been given little serious attention. To be sure a new abnormal internal ring is constructed in the Bassini operation its various modifications and in other plastic operative cures for inguinal hernia but the importance of the normal internal ring its relations and the advisability of reconstructing or imitating the normal characteristic of this opening has been scarcely emphasized.

Direct hernia will not be considered at this time

TREATMENT

Given a man with oblique inguinal hernia on one side and normal inguinal relations on the other as outlined above what could be more rational in an attempt at repair of the hernia than to replace in the normal relationships the various structures on the hernia side.

The essential for the repair of oblique inguinal hernia seem to be

1 The removal of the entire sac

The method of Bassini has become almost a standardized procedure in repair of inguinal hernia but its result is not anatomical in that the red internal oblique muscle is placed around and below the internal ring instead of covering it superficially as it does in normal conditions.

The Bassini repair has been much modified by E. Wally, Andrews, Ferguson, Halsted, Wolfer, Gerard, Fowler and others and more recently by Bates, Harrison, Kerby, Slatterly, Downe, Schley, Stettin, Lyle, Edmund, Andrews, Litzman, Seelig and others.



Fig. 8. Repair of internal ring as done by Edmund Andrews ()

direct hernia or pantaloon sac with finger in peritoneal cavity.

5. Reconstruct the internal ring and posterior wall of the canal ring to be minimized and elevated by repair of the transversalis fascia below the cord which may be carried out in accordance with the method of Gregory Connell 1909 (Fig 6) or that of Marsh Pitzman 1911 (Fig 7) or that of Edmund Andrews 1914 (Fig 8) or that of Major Seelig 1917 (Fig 9). If the transversalis fascia or the posterior wall of the inguinal canal is markedly attenuated some type of plastic operation will be indicated such as the method of Marks (utilization of thick sac wall as suture material) of Wyllis Andrews (imbrication of external oblique aponeurosis) of Mac Arthur (the use of strips of external oblique aponeurosis as suture material) or of Galhe and Le Mesurier (darning defect with strips of free fascia transplant).

6. Remove sac high up leaving no redundant peritoneal pouch outward as a potential sac. Close neck by suture not a simple circular ligature. Suture of internal oblique

muscle to Poupart's ligament is rarely necessary as the internal ring is elevated and usually placed behind the internal oblique muscle.

7. Reconstruct the anterior wall of the canal by suture of the divided external oblique aponeurosis by imbrication or not according to the extent of relaxation.

8. Reconstruct the external (subcutaneous) ring from above downward in this way increasing the obliquity and length of the canal.

9. Close of fascia and skin.

Because of a multitude of variable factors statistics are many times misleading and are notoriously unreliable but Pitzman has well said: "If the theory of this operation is better *ipso facto* the practical result will be better." The result in the individual case may depend upon circumstances other than the method of operative repair such as sex, occupation, age, physical condition, the size and contents of the sac, the accurate differentiation between direct and indirect types, upon technical errors or faults such as failure to remove all of the sac or to recognize a double or pantaloon sac or to remove dilated

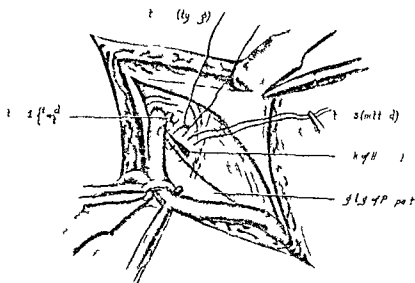


Fig. 1. R p f t l d n b M h P t man ()

utilization of a strip of this same aponeurosis for suture material.

I have utilized the tissue of old large thick sac walls themselves as a living suture material. It is only in large herniae that such material is available and likewise only in these cases that there is a call for such utilization.

Realizing the importance of the natural or normal obliquity of the canal and its valve-like action in preventing hernia and being impressed with the value of the normal inlet to the canal and of its protection by the internal oblique muscle, as early as 1908 I discussed this subject, called attention to the shortcomings of the non-anatomic Bassini and Ferguson methods and presented a technique which repaired the internal ring in such a way as to make the canal the relations of its inlet its wall and its outlet the same as they are in the absence of hernia in effect an anatomical reconstruction of the inguinal canal.

In the literature since then I have found the following authors who have given consideration to the internal ring and its repair: J. M. White, U. C. Bates, R. V. Slattery, H. H. Kirby, Marsh Pitzman, W. S. Schley, L. F. Watson, Edmund Andrews.

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In Pitzman's article entitled "A Fundamentally New Technique for Inguinal Herniotomy" the principle of the object and the method are practically the same as those I had presented in 1909 but with which Pitzman was not familiar.

Our aim in treatment should therefore be to imitate nature, remove the sac and make the canal long oblique and small with an active muscular check at its entrance.

The step in such an attempt may be as follows:
 1. Skin incision. Expose external ring and external oblique aponeurosis; the superficial epigastric artery usually requires ligation.

2. Divide external oblique aponeurosis parallel to fibers, expose the inguinal canal and contents; cord and sac preserving the ilio-inguinal nerve.

3. Mobilize the cord, remove fat and veins if necessary.

4. Isolate and open the sac. Examine the content, replace them, separate adhesion if present, recognize sliding hernia or bladder in wall of sac (rare in indirect hernia). Examine the posterior wall of the inguinal canal, determine the size and position of the internal ring. Search for

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LEAD TREATMENT OF CANCER

By H J ULLMANN M D SANTA BARBARA CALIFORNIA
D t fth D p tm t f C R l t B b C t t g H p t l

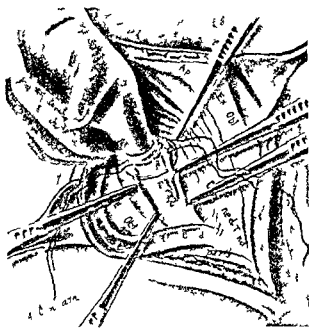
WE have presented evidence in previous publications for the use of colloidal lead orthophosphate rather than the metallic colloid in the treatment of cancer. We have shown both from animal experimentation and from clinical experience that the phosphate is much less toxic to the organism as a whole than the colloidal metal or its other salts (1, 2, 3). We believe that the solutions as generally employed are so toxic that their use is open to question and their keeping qualities are such that it would be difficult if not impossible to bring them into general use. Solutions of lead orthophosphate keep indefinitely at room temperature and apparently do not alter their toxicity with age.

As I have been using lead preparations in the treatment of cancer for less than two years it is too early for me to evaluate the method but I have seen sufficient effect on tumors especially those of the breast to feel considerable encouragement. I do not believe it should at present take the place of the time tried methods of surgery and radiation but should be reserved for those unfortunate who are beyond the reach of either. It is necessary in order to obtain the maximum benefit to combine the roentgen ray or radium with the lead injections and therefore absolutely essential that the user be not only a good clinician but a radiologist as well or be in close co operation with a competent radiologist. He must be familiar with the effects of lead and of radiation not only on the tumor but on the body as a whole and must be prepared to combat lead as well as roentgen intoxication. The majority of patients tolerate lead very well but there are some who are easily poisoned and present the most serious problem of the many involved in this method of treatment. For the present I consider it advisable to hospitalize all patients undergoing lead treatment. It is much easier in a hospital to keep them under close observation and to perform the necessary clinical laboratory work. It is much more difficult to control the diet at the home than at the hospital and the question of diet becomes more difficult as the treatment progresses. Loss of appetite is practically constant toward the end of treatment especially when radiation sickness is superimposed on lead intoxication.

From our experience I believe that the only direct contra indications to the use of the lead phosphate to be a severe anemia and perhaps lung involvement not secondary to breast carcinoma. Several deaths have occurred in our clinic from liquefaction of lung nodules following the injection of both the metallic colloid and the colloidal phosphate. These were metastatic from tumors of the liver, colon and cervical glands. On the other hand lung tumors secondary to breast carcinoma have regressed without untoward symptoms. I have injected the phosphate in several instances where the kidney function as shown by the dye test was almost zero and in one instance was actually zero. No demonstrable kidney injury has been found in any instance so far following the use of the phosphate.

Our technique at present consists in hospitalizing the patient and making a careful examination both physical and laboratory. In addition to the routine examination of the urine and blood the kidney function is estimated by the dye test and blood smears are searched for stippled cells which may be found in some cases of advanced carcinoma before lead is used. The solution of colloidal lead phosphate is then injected intravenously the amount varying with the weight of the patient and the size of the tumor. I have not as yet given more than 0.7 milligrams of lead element per pound of patient net weight. The average dose has been 80 milligrams although we believe larger doses may be safe and perhaps more efficient. Our experience with the metallic colloid has left a great impression and we have been slow perhaps too much so in increasing our dose. Doctors Withers and Ranson of Denver who are using our preparation have given as high as 120 milligrams at each injection and have had some marked regressions and disappearances of tumors. The question of dosage is still under investigation and I believe that we will be obliged to vary it according to the type as well as size of tumor and weight of patient.

Blood counts and the search of smears for stippled cells are made at intervals and if in our opinion the fall in hemoglobin has not been too great or there are not more than an average of one stippled cell per high power field the dose is repeated in one week. These weekly doses are repeated until from 300 to 500 milligrams usually



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vicus or fit upon in order to place stitches under too great tension or upon postoperative complications or accidents. But the most important cause of recurrence is probably the failure to establish the correct relationship between the type of hernia and the character of the operative technique in the individual case, utilizing one method as a routine in all cases of inguinal hernia.

Published statistics show a great variety in the percentage of recurrences after attempt at repair

from less than 1 per cent to 10 per cent for indirect and from 14 per cent to 25 per cent for direct.

Personal cases in the service of Dr. C. J. Combs and myself show with transplantation of the cord the suture of internal oblique muscle under cord 137 cases traced with 8 recurrences 5.8 per cent without transplantation of the cord 16 cases in which the internal oblique muscle is not sutured under the cord 162 cases traced with 4 recurrences 2.46 per cent.

As in all statistics these figures are likewise misleading in that the early simple small herniae are in the more favorable group while the late complicated and larger cases are in the less satisfactory group.

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Fig. 4. Case 2. Photograph, June 1, 1919, one month after treatment with subcutaneous lead.

ment of cancer holds sufficient promise to warrant thorough investigation but the method has not been developed far enough to warrant its general use. Under the best conditions there are many disappointments and this is especially true now when the majority of patients on whom it is tried have reached a stage in their disease when nothing even if it could produce a complete cure of the cancer—as such—could offer hope of recovery so far as the patient himself is concerned.

Two cases are presented to illustrate the effect of lead on cancer of the breast. The first was reported at the Washington meeting of the American Medical Association (3) and is reported again because of the still further improvement of the lung metastases.

This patient was a woman 44 years old who had had a bilateral resection of the left breast 3½ years ago for carcinoma and later subcutaneous nodules were removed on 2 occasions. Roentgenotherapy had also been used. On December 6, 1916 the cancer was a 7 by 14 centimeter tumor in the right breast covered by markedly erythematous skin. Above this was an axillary node about 2.5 centimeters in diameter. Both supraclavicular and cervical regions contained multiple nodules. The supraclavicular space on the left contained a hard tender mass approximately 4 centimeters across. There were multiple subcutaneous nodules scattered over both the anterior and posterior thorax and cutaneous nodules in the region of the operative scar some of which were about to ulcerate. There was separation of both retinae and a slightly painful bulging of the right eyeball.



Fig. 1. Case 1. September 14, 1919.

There was a slight productive cough and dyspnea. Both lung fields were mottled (Fig. 1).

Colloidal lead phosphate was given intravenously. Following the second injection the cough disappeared but pain was felt in all the tumor. A primary swelling of the palpable tumors occurred followed by regression. A radium pack applied over the right temporal region produced immediate relief of the pain and swelling. Anion was completely lost at about the middle period of treatment. Radium packs were applied to the right breast and axilla and left supraclavicular region followed by immediate regression of the tumor. There had however been a reduction in the size of the right breast and a complete disappearance of the erythema before radium was used. The subcutaneous nodules regressed steadily although unradiated and some in the region of the scar disappeared entirely.

The change in the lung fields is particularly interesting (Fig. 2). There was a marked increase in the density and size of the tumor shadows although the patient was clinically better. This was interpreted as due to an infiltration and swelling of the tumor nodules—a lead reaction. Small doses of roentgen rays were then given over the thorax without producing the slightest general reaction. By May 5 the lungs had shown marked improvement and there was regression or disappearance of the visible tumors. The total amount of lead element used was 60 milligrams between December 22, 1916 and August 4, 1927. No further treatment is contemplated unless there is recurrence. The appearance of the lung fields on September 21 was such (Fig. 3) that taken in conjunction with the disappearance of the palpable nodules one is inclined to report disappearance of the metastases as such. The cutaneous subcutaneous and cervical nodules have disappeared. There is a flat symptomless induration found on palpation in the left supraclavicular space. The right axillary



FIGURE 1. Pelvis and lower lumbar spine.



FIGURE 2. Pelvis and lower lumbar spine.



FIGURE 3. Pelvis and lower lumbar spine.

400 have been given. Radiation either radium or the x-ray or both is used when from 100 to 300 milligrams have been injected but great care is taken to prevent radiation sickness. I follow the general plan I outlined several years ago to prevent this (4) and in addition do not hesitate to fractionate the dose to any degree necessary. Blood transfusions are done whenever indicated and it has been found that the general condition of the patient is a better guide to the necessity of such a procedure than the degree of anemia. It must be understood that these procedures are never rigidly adhered to but are modified as necessary in any individual case. No one should attempt the use of lead without first reading all the articles published by Bell and his associates and a thorough study of the entire book—*Lead Poisoning* by Aub Fairhill Minot and Kernikof. The patient is given a 4 to 6 weeks rest and the treatment is repeated until a total amount of from 500 to 1000 milligrams have been given. Two grams of calcium lactate and 1 quart of milk are given each 4 hours if necessary to combat symptoms of lead poisoning.

From our observation during the last 18 months I believe that the use of lead in the treat-



Fig. 1 Tuberculosis of the cecum. Operative case with removal of terminal ileum cecum and ascending colon. Massive tuberculosis of cecum with obstruction and marked tuberculous enlargement of cecal lymph glands.

stages the disease has no characteristic symptoms and is therefore frequently overlooked until effusion takes place. The initial symptoms are abdominal discomfort, loss of appetite and frequent attacks of colic. The presence of these symptoms together with anemia, loss of weight and the typically rounded abdomen should arouse the examiner's suspicion in the direction of tuberculous peritonitis. Various types are found depending apparently on the virulence of the infection and the mode of entrance.

The organisms may enter through the blood stream, the intestinal walls through any caseous focus which may extend to the peritoneum or most frequently of all through the fallopian tubes. In most instances abdominal tuberculosis is secondary to an infection elsewhere, but this is often difficult to prove.

Macroscopically we find minute miliary tubercles on the peritoneal surfaces and in the omentum without any accumulation of fluid or exudation of fibrin. In other cases a quantity of clear or turbid fluid is present in the cavity. Usually the amount of fluid is small, but it may be found in quantities large enough to distend the abdominal cavity.

In this moist form the patient loses weight and strength rapidly. The abdomen has a characteristic paleness and the skin is silky. When the abdomen is opened a thin fluid escapes. Flakes of fibrin may escape with the fluid. The fluid having escaped the surface of the peritoneum is seen to be studded with fine tubercles. Some of the tubercles may be of considerable size. Masses of caseous mesenteric glands may now be palpable. The omentum may be greatly thickened and



Fig. 2 Tuberculosis of the ileum with tuberculous ulcerative enteritis. Young and old tuberculous process in the ileum, some with benign ulceration and others with advanced ulcerative change. Note the typical transverse disposition of the advanced ulceration. Autopsy showed a bilateral caseous ulcerative pulmonary tuberculosis, the extent of tuberculous enteritis and ulceration, also localized tuberculous peritonitis of the ileum.

infiltrated. In the dry variety there is no effusion and extensive adhesions may form between the intestinal coils. Frequently a fecal fistula is present. The surrounding tissue is inflamed and the blood vessels distended.

TUBERCULOSIS OF THE INTESTINES

Tuberculosis is the most frequent cause of inflammatory affections of the bowel. Tuberculous lesions are rarest in the duodenum, becoming more frequent as one nears the ileocecal valve. As to the mode of entrance, except in the cases of children in which the tubercle bacilli may reach the bowel through the digestive tract, the bacilli pass



Fig. 3 Tuberculosis of the spleen. The spleen is enlarged, the capsule fibrous and thickened. There are disseminated miliary tubercles throughout the parenchyma with occasional a glutton on between tubercles. Autopsy showed a generalized miliary tuberculosis involving the spleen, liver, omentum, mesentery, small intestines and lungs. There is also a right psoas abscess with early necrosis of adjacent vertebral bodies.

nodule is gone and a slight diffuse rubbery in duration is all that is left of the mammary tumor. Vision in the right eye is lost but pictures can be recognized with the left and she is able to write letters and read fairly large writing and to go about town without assistance. She is gaining weight and feels well. There is no evidence of chronic plumbism.

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INTRA-ABDOMINAL TUBERCULOSIS

By LIO DRETZKA MD FAC S DETR I M CI

TUBERCULOSIS has almost as many angles of interest as syphilis. It has its sociological, hygienic, genetic, occupational, and psychological aspects in addition to its medical and surgical phases and we can not approach it from any of these viewpoints without considering the others.

The ultimate conquest of tuberculosis and statistics give us sound reason to believe that it will eventually become as rare in civilized countries as cholera will be the triumph of the hygienist and epidemiologist. The surgeon's aid in the treatment of individual cases must be regarded as only a temporary recourse, an emergency measure applied in lieu of something better. The physician should call upon the surgeon for co-operation only when the tuberculous infection is not to be reached by any other method and if surgical interference is to justify itself the postoperative treatment must be recognized as by far the most onerous aspect of the case when the tuberculosis has progressed into certain tissues.

The results obtained in tuberculous infections with direct sunlight and proper hygienic conditions have been most encouraging in recent years. If all patients could be given this treatment for an unlimited period of time surgical treatment should really be deferred in the majority of cases of intra abdominal tuberculosis. Unfortunately our patients in most parts of the United States cannot be given ideal climatic conditions.

During 1924 and 1925 I studied 72 cases of surgical tuberculosis of the various abdominal organs. Of this group 16 were cases of definitely primary abdominal infections in so far as could be determined by examination. In other words the respiratory organs were normal as were all parts of the body excepting the affected part and the end result after surgical intervention indicated a complete recovery.

TUBERCULOSIS OF THE PERITONEUM

Tuberculosis of the peritoneum is most common in children and young adults. In the early

enteric glands are infected by the bacilli which pass through the bowel wall (Fig. 4).

Tuberculosis of the uterus most frequently follows a tuberculous infection of the tubes. The disease occurs in the form of nodular or diffuse infiltration which resolves itself into ulceration or necrosis of the mucous membrane and submucosa. The entire organ may be covered by necrotic and caseous deposits.

TUBERCULOSIS OF THE FALLOPIAN TUBES

In the female genital tract the fallopian tube is the most frequently infected by the tubercle bacillus. The fallopian tube is usually the primary seat of the disease and a large majority of cases of general abdominal tuberculosis and tuberculous peritonitis is due to an extension of the infection from this point.

The susceptibility of the fallopian tubes to this form of infection is explained on the ground that the mucosa offers a fertile bed, the result of superposition of the circulatory changes occurring at menstruation. This probably accounts for the fact that the infection takes place often between the periods of puberty and the menopause or in other words during the active sexual life.

As a result of improved methods of diagnosis an increasing number of cases of tuberculosis of the oviduct are being reported as primary.

In my series of cases there are 3 in which the oviduct is the only site of tuberculosis. I think much caution should be exercised in pronouncing the condition primary, only after the most meticulous examination is such a diagnosis warranted.

The pathologists inform us that the mucosa is the first portion of the tube to be attacked; the infection then spreading until all coats are affected. Tubercles are present on the peritoneal surface of the tube in only about 50 per cent of the cases. But the flare of the imbricated end of the tube glistening and moist is quite characteristic. The tube may be normal in size or greatly enlarged. Caseous material is often seen and in advanced cases the peritoneal surface is coated with a yellowish gray cheesy material. Certain types of tuberculous salpingitis resemble chronically infected tubes and cannot be distinguished from pyogenic infections. Eucorrea is present in 75 per cent of the cases.

The macroscopic diagnosis of tuberculous salpingitis is entirely misleading. The tubal tuberculous involvement is most frequently discovered by histological examination. The uncertainty of an accurate macroscopic examination accounts for the divergent opinion regarding its frequency.

Statistics which place the incidence of genital tuberculosis at from 1 to 1 per cent are unreliable because there is no evidence that a routine histological examination has been made. The University of Pennsylvania has found that in their series of cases 7 per cent of all inflamed fallopian tubes are tuberculous.

During 1923 and 1924 15 cases of salpingitis were operated on at St. Mary's Hospital. Of this number 85 per cent were reported as tuberculous. All operative material at our hospital is subjected to histological examination.

A description of the characteristic symptoms of tuberculous salpingitis is quite impossible. In the earlier stage of the disease recurrent attacks of pain and tenderness with some degree of menstrual disturbance may be present. Elevation of temperature is common. When it is remembered that the abdominal ostium is usually open and the tube patent it is understandable how obscure early symptoms may be. As the disease progresses adhesions may obstruct the lumen of the tube and the tube may become adherent to the bladder with resultant urinary symptoms. Secondary anemia is present in the majority of cases with resultant menstrual differences. These symptoms are likewise characteristic of pulmonary tuberculosis. The symptoms resemble any pelvic inflammatory condition in its varied degrees with the exception that in tuberculous infections the acute symptoms are vaguely marked while the constitutional symptoms are often very pronounced. Sterility is frequent and in my series 90 per cent of the patients were apparently sterile.

The operative mortality in properly selected cases of tuberculosis of the tube is no greater than that of other tubal infections. We must consider however that the condition is usually secondary to tuberculosis elsewhere and this of necessity makes the risk greater and the choice of anasthetic more important.

Operative treatment. Excision of the diseased parts is the necessary operative procedure. In my opinion conservative measures rather than radical ones get desired results. In other words if the tubes alone are involved macroscopically, a pan-hysterectomy is not indicated but the tubes should in all cases be excised out of the cornu of the uterus. The ovary is rarely attacked by the tuberculous process. A perioophoritis may be present but it is usually an inflammatory extension. If degeneration is not present the ovaries should not be removed. The condition here is similar to that in the male in which the epididymis is infected frequently and the testis

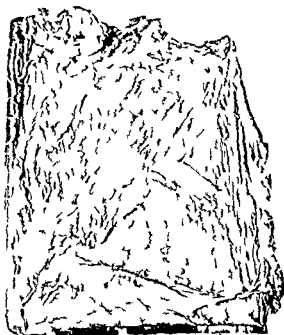


Fig. 1. Tuberculous ulcer of the ileum. The ulcer is large and irregular, with a deep, crater-like center. The surrounding tissue is inflamed and edematous. The ulcer is located in the ileum, which is the terminal part of the small intestine.

Fig. 2. Tuberculous ulcer of the ileum. The ulcer is large and irregular, with a deep, crater-like center. The surrounding tissue is inflamed and edematous. The ulcer is located in the ileum, which is the terminal part of the small intestine.

The ulcers are irregularly distributed but are usually in the region of the ileum (Fig. 1 and 2).

A tuberculous inflammation of the ileocolic glands often simulates appendicitis.

TUBERCULOSIS OF OTHER ORGANS AND GLANDS

Tuberculosis of the stomach wall or the existence of tuberculous ulcer of the stomach is comparatively rare although with the swallowing of tuberculous sputum one would expect the direct opposite. The tuberculous ulcers that are found are probably primarily ordinary gastric ulcers infected by the organisms.

Tuberculosis of the gall bladder is extremely rare and simulates gall bladder disease in general.

Tuberculosis of the liver is not uncommon but is seldom extensive and for the most part consists of minute tubercles scarcely visible. It is always secondary.

It is doubtful if tuberculosis of the spleen is ever primary. Frequently however the spleen is involved along with other organs (Fig. 3).

Involvement of the cervical bronchial and mesenteric lymph glands is common occurring most frequently during childhood. The presence of milk during recent years as well as the hygienic inspection of school children has done much toward eliminating this infection. The mes-

through the stomach and lodge on the intestinal mucosa either in the lymph nodes or elsewhere. There inflammation is followed by ulceration of the mucosa and submucosa. The gastric ulcer follows. The inflammatory process may extend through the muscular coat and a perforation result but the inflammatory thickening of the tissues usually prevents a rupture. Adhesions to surrounding parts are common. The surgical importance of ulcerative tuberculosis is in which extensive ulceration has been present lies in the fact that healing is followed by scar contraction. Intestinal obstruction may result and is treated in the regular manner. The tuberculous condition is unrecognized until symptoms of obstruction present themselves.

During the operative procedure the entire intestinal tract is systematically examined by beginning with the cecum and tracing its course and following the small bowel down from the jejunum. The bowel must be handled with extreme gentleness and care. Shock must be minimized. Though handling of the bowel may result in an active inflammatory reaction.

SYNOVECTOMY OF THE KNEE JOINT

BY CLAUENCE H. HEYMAN, M.D., F.A.C.S., CLEVELAND, OHIO

IN recent years the operative removal of the synovial membrane to relieve various affections of the knee joint is becoming more and more recognized as a valuable procedure. Although the writer's series of cases is not large, 7 cases of the complete operation a sufficient length of time has elapsed to form conclusions as to its value. It is believed that synovectomy in the properly selected case is a procedure of great merit and has been the only method of obtaining relief for those patients operated upon. It is also the writer's belief inasmuch as a practically normal range of motion has been obtained in all excepting 1 case in which the infectious nature of the disease was not quiescent that the indications may be broadened to include that class of cases in which there is painful and limited motion following trauma with recurring synovitis of not clearly understood etiology. It is the purpose of this paper to discuss the indications for synovectomy and the rationale of treatment.

By synovectomy we mean the excision of the synovial membrane as the principal seat of the local pathological change. Strictly speaking the term synovectomy means the complete operation, i.e. the removal of all the synovial membrane which of course includes that of the quadriceps pouch, the infrapatellar fat pads and the semilunar cartilages. However I do not wish to limit the discussion to the complete operation as there are certain types of cases in which all of this is not necessary or advisable and will therefore include in this paper a discussion of those conditions in which only a partial synovectomy is advisable.

The classification of arthritis adopted here while not satisfactory as I believe the best we have I shall not attempt to go into the etiology more than is necessary to determine the indications for synovectomy.

Synovectomy is not new. Although it had long been employed in the treatment of tuberculosis there is only an isolated report here and there of its use in the so called arthritis cases. Goldthwait (1) in 1900 was probably the first in this country to remove the thickened synovial membrane in several knees with a constant excess of fluid pain and grating on movement. Murphy (2) in 1916 reported 2 cases of synovectomy in villous arthritis.

More than a passing interest however was not aroused until in 1920 when Swett (3) read his

paper at the American Orthopedic Association on

Synovectomy in Chronic Infectious Arthritis. Although it is not the rule micro organisms have frequently been found in the stained synovial membrane removed at operation and obtained in culture from the synovial exudate. The acutely painful swollen and tender joint with local heat and elevation of body temperature leave no doubt as to the infectious nature of the process within the joint but it is the exception rather than the rule that positive cultures are obtained even though the aspirated fluid is cloudy and the sediment shows a large number of pus cells. New laboratory methods as suggested by Burbank are quite likely to demonstrate the presence of the offending organisms in a far greater number of cases. Swett reasoned therefore that these organisms are capable of continuing the activity of the process within the joint as well as causing metastases into other and previously uninvolved joints and that there is as much logic in their removal as there is in the elimination of the original portal of entry. In other words the infected synovial membrane is itself a source of infection and remains so even after all other foci have been removed. He also believes that a prompt restoration of function stimulates local metabolism which Pemberton has found to be fairly constant as a suboxidation process which prolongs the arthritis.

Before we proceed to a discussion of the selection of a diseased joint suitable for synovectomy it will be necessary to review briefly the anatomy and the changes present in arthritis. It is apparent that the better we understand the reactions of synovial membrane to injury and toxins the fewer mistakes we shall make in selecting our cases for synovectomy.

The synovial membrane lines the deep surface of the ligamentous structures of the lateral and anterior parts of the joint. It is reflected over the semilunar cartilages the infrapatellar fat pads and the crucial ligaments on the anterior and lateral aspects. It does not completely invest the posterior surface of the posterior ligament. In the anterior part of the joint it is prolonged proximally beyond the articular surface of the femur in the form of a pouch under the cover of the quadriceps tendon. The subcrureus muscle is inserted into the wall of this pouch and its function is important as it prevents pinching and injury to

rarely. If the infection is unilateral both tubes should be removed since repeated histological examinations have proved that this is the safer procedure.

The general operative technique of pelvic surgery is followed. If a mixed infection is suspected the abdomen should be drained. Analyzing the operative results of 200 cases at Johns Hopkins Greenberg reports that of 104 cases in which drainage was used fecal fistulae followed in 18 while in 96 in which drainage was not used no fistulae followed. As it is impossible to eradicate the process entirely by excision continued minute detailed attention to the general health of the patient is necessary.

The question of whether to drain or not is determined solely by the nature of the infection encountered. If the infection is mixed drainage is indicated; if it is exclusively tuberculous no drainage is used.

After the patient leaves the surgeon's care the real fight begins. It is almost needless to say that the personality and economic status of the patient are all important factors. A great many victims of tuberculous infection are saved in spite of themselves. During my connection with public clinics I saw numbers of patients who after being treated surgically for tuberculous infections of the abdomen, if left to themselves or to casual

medical care would return to the most unfavorable surroundings and die a little sooner than otherwise. I have seen patients too ignorant and stubborn to go to public sanitariums, compelled by the physician to spend their days exposed to the sun and air perhaps in some squalid courtyard screened against flies, given the proper diet and kept from premature exertion while incredulous relatives sneered at the fussiness of the doctors, social workers and visiting nurses. But since tuberculosis is a far more dangerous disease from a public health viewpoint than leprosy, the responsibility of the physician in regard to it must never be limited by the personal notions of its victims.

SUMMARY

When tuberculosis involves organs of the abdomen and the general condition of the patient is sufficiently good surgical interference is indicated. It is important first to determine whether the patient has the vital reserves which will make the operation beneficial and then to perform the operation with due respect for the generally weakened physique. I refer to the careful minimizing of shock, the delicate handling of tissues and the judicious selection of an anæsthetic and its mode of application. The postoperative care which by no means ends with the primary healing process is of the utmost importance.

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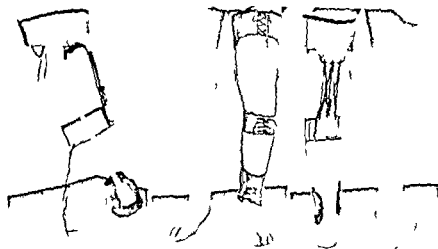
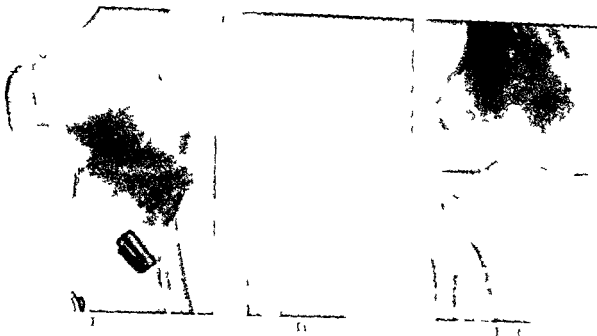


Fig 3

Fig 4

Fig 5

The synovial membrane on extension of the knee. The synovial membrane also invests the semilunar cartilages and a pouch like diverticulum is prolonged posteriorly and distally along the tendon of the popliteus which it partially encloses thus forming a posterior compartment connected with the anterior chamber by narrow

passage. Fibers of the gastrocnemius are attached to the posterior capsule thus assisting in the locking and preventing the pinching of the synovial membrane when the knee is flexed. The infrapatellar fat pad requires particular mention because of its frequent hypertrophy and consequent internal derangement of the knee

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The pad is extrasynovial but intracapsular and is placed under the deep surface of the patellar tendon and fills up the interval between the patella femur and tibia adapting itself to the various forms which this recess adopts in the different movements of the joint. The synovial membrane separates it from the interior of the joint and from its surface a band of this membrane extends to the intercondylar notch where it is attached. This band is termed the ligamentum mucosum and its lateral prolongations inserted into the capsule are the alar ligaments. These are not ligaments in the ordinary sense of the word but are merely folds of synovial membrane. Contraction of the subcrureus muscle transmitted through the capsule and alar ligaments is believed to pull the fat pad up out of danger on extension of the knee. Thus it may be seen that an underdeveloped quadriceps muscle may result repeatedly in injury to the synovial membrane on motion of the joint. We may say in passing that physiotherapy directed toward increasing the muscle tone and the developing of this muscle is important in the treatment of knee joint disease and in postoperative cases. Massage directly over the capsule and synovial membrane is contra indicated as it leads to still further irritation congestion swelling and so forth.

Synovial membrane which has been traumatized becomes congested and swollen and there may be small extravasations of blood with exudation of a thin yellowish fluid containing small flocculi of fibrin. The reactions to injury and infection are very similar and are manifested clinically as synovitis or thickening of the synovial membrane and joint capsule. In more severe cases the exudate becomes more abundantly fibrinous and the synovial membrane is thickened swollen thrown into folds with villous projections and infiltrated with inflammatory products. In the chronic inflammations pannus like growths may extend over the articular surfaces from the periphery and there may be hyaline or fatty degenerative changes of the deposition of cartilage or bone within the synovial membrane. Static defects may cause relaxed lateral ligaments with a less stable joint and therefore increase susceptibility to injuries and toxins.

I shall not attempt to go into the causes of chronic arthritis. When we speak of chronic arthritis it is important to specify which particular type we have reference to as there appear to be at least 3 distinct types each having a different cause. Data on procedures such as the removal of foci of infection are of no value unless the particular type of arthritis under considera-

tion is specified. For example if we were removing foci of infection in those types of arthritis probably caused by trauma or strains our results would naturally not be encouraging and in reporting our failures we would condemn the procedure as having no value in the treatment of chronic arthritis in general while there is no question as to its value in the treatment of the infectious type. Similarly all types of arthritis are not accompanied by marked changes in the synovial membrane and it is irrational to expect favorable results from synovectomy in all such joints. A discourse on synovectomy in chronic arthritis is therefore of no value unless we are able to recognize the type for which we are proposing synovectomy. This is not always easily determined as there are mixed types which can not be accurately classified.

It is unfortunate that there is no commonly accepted classification or nomenclature. There are or have been at least 14 different classifications each having its own adherents. Until there is agreement as to etiology there will continue to be different classifications thus causing the utmost confusion. It is necessary to be familiar with the different classifications if we are to interpret reports intelligently. For example when Ellis speaks of Type 1 he has reference to the infectious or atrophic type while Fisher in speaking of Type 1 refers to the hypertrophic type. The importance of a standardized classification is therefore apparent.

In this country probably the most commonly accepted classification is that which recognizes 3 distinct types the infectious, the atrophic or rheumatoid and the hypertrophic or osteoarthritis. We shall not enter into a discussion of the etiology of the different types of arthritis. Suffice it to say that the infectious type is clearly caused by the spread or the absorption from some source of infection. There may or may not be an actual invasion of the joint structures.

The evidence is not conclusive that the atrophic and the hypertrophic types are infectious in origin. The rationale of synovectomy is either the removal of the focus of infection within the joint itself or the removal of the sources of mechanical irritation. For the present our indications must therefore be confined to the infectious type or to any type in which large synovial fringes or cartilaginous bodies are aggravating the inflammation by forming obstacles to motion.

INDICATIONS FOR SYNOVECTOMY

Careful selection of cases is necessary. The disease must be localized in one or a few joints

and the disease must be quiescent. The object of synovectomy as in other forms of treatment is first to relieve the patient from pain and second to restore the maximum degree of function. Although a focus of infection may be removed by synovectomy and symptom in other joints may be relieved thereby I believe that further work and observation of cause are necessary before we are justified in doing a synovectomy merely to remove a focus of infection for the benefit which may accrue to other joints. Conservative treatment demand at least for the present that the operation be confined to the removal of chronically infected synovia for the benefit of that particular joint to those cases in which the synovial changes are of sufficient degree to cause an actual impairment of motion or to cases in which motion causes further irritation congestion or proliferation of the synovial membrane or fat pad. Of course before synovectomy is resorted to the commonly recognized foci of infection should have been investigated and treated and physiotherapeutic measures must have proved ineffective.

If inflammation is still acute extensive destruction may result in such a degree of reaction of tissues as to produce an extensive scar formation which will limit motion. It is difficult clinically to determine quiescence and errors in judgment are apt to occur. It was common experience in the infected war wounds that even after healing of a wound had existed for months extensive traumatism of the previously infected tissues resulted in an acute flare up of a dormant infection. The following case is illustrative.

C. T. a 39 year old female, had a history of arthritis going back to the set of the knee joint. The patient in the past had a fall from a horse and was injured. She had a history of rheumatism and had been in the hospital for several months. She had been unable to work for the past three years.

On December 7, 1934, she was admitted to the hospital. She had a history of arthritis and had been in the hospital for several months. She had been unable to work for the past three years. She had a history of rheumatism and had been in the hospital for several months. She had been unable to work for the past three years. She had a history of rheumatism and had been in the hospital for several months. She had been unable to work for the past three years.

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Although at the time of operation considerable roughening of the articular surfaces was noted the resulting decrease in motion is not attributable to the destruction of joint cartilage. There was local heat before operation which became decidedly more pronounced after operation with considerable pain on active and passive motion. This type of case although relieved from pain would seem to indicate from the microscopic appearance of the synovia that a lessened range of motion may be expected.

It is also to be remembered that cases of a low grade synovial tuberculosis may not be suspected clinically and may be of long standing. If there is any question as to the accuracy of diagnosis, excision of a piece of synovia for laboratory diagnosis is essential. Figure 1 is the roentgenogram of a patient 6 years old who had only a moderate limp and stiffness of 8 years duration. Although the roentgenogram showed no bone atrophy and there was no apparent destruction of the articulating cartilage the microscopic examination of a piece of synovia removed for diagnosis revealed tuberculosis.

Steindler (4) emphasizes the important point that it is difficult to judge the degree of articular destruction and in the event of considerable erosion of cartilage with pannus formation a certain latitude of action should be reserved by the operator and the indication for simple synovectomy should be changed to fusion and stabilization.

Traumatic cases Extra aspirations of blood in the synovial membrane as a result of trauma may set up an inflammatory reaction consisting of small mononuclear and perivascular infiltration practically identical to that caused by infection. Sprains of lateral ligaments repeated dislocations of the emulnar cartilages loose bodies or enlarged fat pad which are caught between the articulating surfaces may cause permanent

damage to the synovia resulting in disability even after the original offending factor has been removed. The anterior aspect of the knee is sensitive and extension of the knee is painful and limited.

Under this heading may be mentioned hypertrophied infrapatellar fat pads. Through trauma or from the absorption of toxins the fat pads become swollen. On full extension of the knee the enlarged fat pad becomes pinched between the articulating surfaces. As a result of this mechanical irritation it becomes still further swollen and congested and therefore still more likely to be pinched. The patient complains of pain at the infrapatellar region on extension of the knee and there is tenderness on each side of the patellar tendon. Because of the pain an early atrophy of the quadriceps muscle develops and the fat pad is not protected by the action of this muscle from injury. Thus a vicious circle follows. The treatment of this condition is not fixation—as this causes a further atrophy of the quadriceps—but measures to prevent complete extension of the knee by means of suitable apparatus. If after a reasonable length of time recovery does not follow, it is conservative treatment to remove the offending fat pad before irreparable damage to the synovial membrane results. This may be done through lateral incisions.

The writer has not found the Jones knee cage brace a satisfactory apparatus to check movement of the knee short of complete extension. Even very tight strapping both above and below the knee does not prevent it from slipping downward so that the hinge is not opposite the axis of motion in the joint. The tight bands also cause swelling about the knee and leg through passive congestion and the pressure of the straps over the quadriceps causes an atrophy of this muscle. Patients also object to a brace extending to the sole. Figures 3, 4, and 5 show a brace which has proved to be very satisfactory in checking complete extension of the knee. It remains in place and is comfortable to the patient. Tight lacing is not necessary.

Chronic inflammation. There is a second group of cases in which the bone changes may be slight or absent. The synovial hypertrophy becomes extreme forming pedunculated growths. This is commonly called villous arthritis. The synovial membrane is markedly hypertrophied and is thrown into folds or villi thus giving the surface a velvety appearance. Clinically this type of joint shows more or less swelling with increase in fluid, thickened capsule and a doughy consistency. There is marked grating or joint crepitus.

The villi project themselves between the articular margins and are thus subject to repeated traumata. This villous hypertrophy is not nearly so prominent a feature in the hypertrophic arthritis as in the atrophic and infectious arthritis. Its effect is to cause mechanical obstacles to free motion which of course must aggravate the existing inflammation. A vicious circle again develops and the benefit of removal is evident. In this type of case excision of the entire synovial membrane is indicated and if the semilunar cartilages are thin or frayed out these also should be excised. It is just a question of degenerative changes from this condition to that of the next group or osteochondromatosis.

Figure 6 is the roentgenogram of a man aged 46 years who for the last 6 years complained of pain and stiffness in the right knee. There was an extreme doughy swelling about the knee and very marked grating on movement. There was only 40 degrees motion between 110 and 150 degrees. There was no acute tenderness. For almost the entire past year he was able to work only at a sitting job. The roentgenogram shows but little bone change. He returned to work at a standing and walking job in an automobile factory 7 weeks after operation with 60 degrees motion and has been working steadily ever since. At present he has 90 degrees motion between 90 and 180 degrees.

Osteochondromatosis. In osteochondromatosis there are numerous cartilaginous bodies of various sizes within the joint. They have their origin in the synovial membrane. They may be free or attached by a pedicle or may be completely hidden from view buried within the thickened synovial membrane. It is therefore impossible to remove all of these bodies without removing the synovial membrane. Even if this were possible it is likely that others would form to give trouble later.

Hypertrophic arthritis. Loose bodies in the joint may form from fractured nodules generally from the femoral and patellar surfaces. These are commonly called joint mice. Since their origin is not from the synovial membrane synovectomy is not indicated unless secondary synovial changes as a result of the repeated traumata caused by these joint mice are sufficient to give trouble even after they have been removed.

Synovectomy should not be recommended as a procedure to increase the range of motion when the patient's chief complaint is stiffness, and not disability because of pain. However the removal of the source of irritation and infection is expected to result in a greater range of motion. Complete

removal of the synovial membrane is bound to result in a more or less scar formation which may limit motion but if the disease is mainly confined to the synovia without marked destruction of cartilage an increased range of motion may be expected. It is not safe to promise the patient a greater range of motion because of the difficulty in determining quiescence or the degree of cartilage destruction as mentioned before. Swett however advises the operation in joints in which the process is still active.

Synovial membrane regenerates after synovectomy. The experimental work by Key (3) showed that new synovial membrane is formed by metaplasia of underlying connective tissue. His observations have been confirmed by Wolcott (6) who in addition has demonstrated the regeneration of the infrapatellar fat pad.

DESCRIPTION OF THE OPERATION

A longitudinal incision is made over the anterior surface of the knee directly in front of the patella. The incision extends upward and is carried through the quadriceps tendon and downward through the patellar tendon. The patella is split or sawed through vertically just medial to the middle line and the two halves are retracted widely giving a very complete exposure of the joint. It is best to do the operation under a tourniquette as the chronically inflamed tissues bleed freely and hemorrhage is difficult to control. It is also advisable to prevent bleeding as much as possible so as to minimize frequent pouging which may injure the delicate articulating cartilage. Sponging is best done by soft pledgets of cotton.

The entire synovial membrane is then carefully dissected away down to the joint capsule and the infrapatellar fat pad removed as well. If the cartilages are damaged these are also removed.

Before closing the wound the tourniquette should be removed and the greatest care taken to control hemorrhage. If blood is left in the joint it organizes and forms adhesions which will pre-

vent free motion and cause pain and may cause a destruction of the articulating cartilage. The wound is carefully closed in layers. It is not necessary to pass sutures through the patella. Interrupted chromic sutures through its thick and tough periosteum is sufficient.

For the first 4 days the joint is kept at rest mainly to prevent intra articular bleeding which forms adhesions. A Thomas splint which has been provided with a hinge at the knee joint is applied with moderate traction. Active motion is insisted upon gradually increasing in range from day to day. It is important that complete extension be at all times possible. If motion is pushed too rapidly this may be lost as it is easier to flex the knee than extend it. After 2 weeks crutches are allowed with light weight bearing. Much more rapid progress is made when the patient is up and can force flexion by placing his foot on the floor. I do not believe that passive motion is of much assistance but early massage to the quadriceps muscle hastens recovery because of the atrophy which follows opening the joint. Too vigorous treatment does harm as it leads to irritation muscle spasm and a loss in the gain of motion. Forable manipulation under a general anesthetic should not be necessary and one should be extremely cautious in its use. Gentle manipulation may be permissible after the end of 2 weeks but the joint should be put through its range of motion only once. Great care must be used to avoid causing any active inflammation as the inflammatory products are likely to result in still more extensive formation of adhesions. As a rule crutches may be discarded at the end of the fifth week.

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AN ANOMALY OF INTESTINAL ROTATION

BY J. W. GRANT AND F. C. S. CARDIFF WAITS

EXAMPLES of abnormal position of the abdominal viscera have been reported at various times by surgeons and anatomists but only lately has their importance been adequately appreciated.

A failure of the third stage of rotation of the mid gut loop in which the ascending colon and caecum normally lose their primitive mesentery and by the process of zygosis become fixed to the posterior wall of the right loin and the fossa is by no means uncommon and varies in degree from an unduly mobile caecum to a floating caecum and ascending colon which retain their primitive mesentery a subject which has recently been fully treated by Waugh (4).

A case of this kind I recently came across in the course of an exploratory laparotomy on a man of 76 suspected to have a growth of the ascending colon. A caecum and ascending colon with a complete mesentery were readily brought out on the surface and the supposed growth proved to be a mobile kidney. His symptoms of discomfort in this situation were only of 3 months duration and it appeared probable were due to the kidney having recently become mobile owing to loss of fat. An interesting feature was that the mobile caecum and ascending colon had never caused him trouble in the course of a long and active life. The case here reported is one of failure of the second stage of rotation. It is the first of its kind that I have come across or at any rate recognized and as the condition is decidedly rare and also somewhat puzzling when found it appears worth recording in some detail.

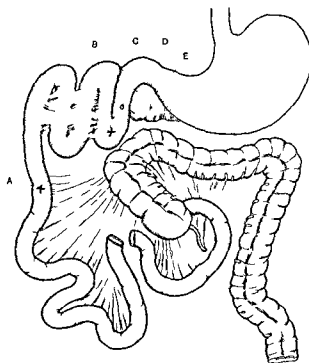
Mrs A. N. aged 57 years the mother of four children was sent to me with the following history. For many years she had suffered from epigastric pain shortly after meals and a feeling of fullness and flatulence which were relieved by the belching of wind or by the removal of her corsets. During the past 6 weeks her symptoms had become greatly aggravated vomiting had supervened and she was practically unable to keep down any food. It appeared to me to be a case of cholecystitis (which opinion I subsequently heard from her doctor as also his own) and I advised operation regarding which she was at first most averse. However her symptoms became so distressing that she urged that the operation be performed earlier than had been fixed and I was informed that the night preceding the operation the belching of wind was incessant.

Laparotomy by a right upper paramedian incision disclosed a normal appearing stomach and first stage of the duodenum. The gall bladder contained no stones but as there were some yellow streaks of lipid material in its

wall and a deposit of fat at the neck it was removed with out any difficulty. A mobile caecum with a complete mesentery was brought up into the wound. The ileum entered it on the left side normally and the appendix showing no evidence of disease was returned into the abdomen. It was then noticed that a large amount of small intestine lay to the right of the caecum and ascending colon and when these were traced up it was found that in the right hypochondrium there was a series of U shaped loops plastered on to the posterior abdominal wall. They were linked moderately dilated and fixed to each other by membranous adhesion. The hand passed below the transverse colon failed to find the duodenojejunal flexure in the normal situation. An attempt was then made to unravel the above mentioned adherent coils when it was found that they comprised the second and third stages of the duodenum and passed insensibly into the jejunum. This condition shown in the diagram was verified by a limited examination postmortem. The superior mesenteric artery did not cross the duodenum but ran down to the right of the caecum and ascending colon. As it then became apparent that her symptoms were in all probability due to a form of chronic duodenal ileus an attempt was made to relieve this by anastomosing the first free portion of jejunum to what corresponded to the second stage of the duodenum and it appeared that this had been done without causing any kinking. However regurgitant vomiting followed the operation persisting in spite of washing out the stomach so that it became necessary to re-open the abdomen 4 days later. Although the efferent limb was linked at the site of anastomosis and the drainage of the loops was not efficient they were only moderately dilated and the stomach not at all but there was great distention of the whole of the remainder of the small intestine which appeared to be in a condition of paralytic ileus. A jejunostomy was performed but the patient's symptoms were not relieved and she succumbed on the following day.

The great distention of the distal small intestine suggests that a partial torsion may have occurred as in the condition described by Dott (5) as mal rotation but in the limited examination permitted postmortem this could not be determined and in the course of an operation such complicated conditions are often difficult to determine with accuracy. As regards the original operation of jejunoduodenostomy an anterior gastrojejunostomy would have been far preferable and might have been attended with a different result. It is for this reason that in obscure abdominal conditions in which no very definite cause is found when the abdomen is opened their possible presence should be borne in mind and the most appropriate method of dealing with them carefully thought out.

A reference to the diagram shows two U shaped coils. In the angle between the descending limb of the first and the pyloric portion of the



1 St. of anatomical opening of junction B t f
 anatomical opening of duodenum C it at on f b l
 p illa D pylorus E head of pnc

stomach lay the head of the pancreas and the common bile and pancreatic ducts opened into the middle of this limb in the normal situation.

In this connection the report of a case of Extensive Diverticulosis Without Symptoms by Norman Corkhill (1) is of great interest. I quote the portion which is relevant to this case.

The duodenum with the superior mesenteric artery on its inner side turned back on the head of the pancreas in the shape of a double S. The duodenojejunal flexure was at McBurney's point the mesentery running thence upward to the left

The mesenteric cæcum which was entered by the ileum from the right was slightly to the left of the midline in the upper umbilical region.

These two cases my own and that reported by Corkhill are examples of an anomaly of the second stage of rotation of the mid gut loop that portion of the intestine extending from the bile papilla to the region of the splenic flexure. Anomalies of intestinal rotation form the subject matter of a paper by Dott (2) in which after describing fully normal rotation he cites three cases: one in a man of 68 with reversed rotation, one of non rotation with volvulus in an infant, and one also in an infant of a similar nature.

Keith also briefly mentions these anomalies (3). The anomalies of the second stage are (1) non rotation (2) reversed rotation in which instead of the cranial extremity of the bowel first entering the abdomen in the counter clockwise direction the caudal extremity passes in first the rotation being clockwise and the superior mesenteric artery lies in front of the transverse colon. It would appear that the first variety may cause no symptoms (Corkhill's case) or symptoms may be due to chronic duodenal ileus from duodenal kinking (my own case) or possibly partial torsion of the U shaped loop may occur and rectify itself or else may give rise to a complete volvulus as in the condition described by Dott as mal rotation.

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 m b l cæc m a d a s d n g c l o B t J S r
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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1928

DIAGNOSIS THE CRUX OF THE PROBLEM OF ACUTE OSTEOMYELITIS

THE comparison between acute appendicitis and acute osteomyelitis is not a new one. More than one writer has pointed out that the diagnosis of one condition is no more difficult than the diagnosis of the other and that prompt treatment is equally important in both. Unfortunately, however, the comparison ceases at this point. In the great majority of cases today acute appendicitis is promptly diagnosed and promptly treated by the correct surgical measures. But acute osteomyelitis is diagnosed correctly only in a relatively small percentage of cases and it is treated so largely by medical methods that more than one observer—the writer is numbered among them—tutes without qualification that acute osteomyelitis is practically never seen in its initial stages in the surgical wards of public hospitals. The general practitioner is blamed unjustly for many things, but the tragedies of acute osteomyelitis only too often lie at his door. He sees the patient first, he makes the diagnosis in a regrettably large number of

cases he makes it incorrectly and he uses temporizing medical measures (chiefly the administration of salicylates) at the only time when benefit can be expected from anything short of a mutilating operation. Then when the damage is done when the true condition is revealed the patient is turned over to the surgeon who is expected to work the miracle of a cure in the face of extensive bone destruction and lessened constitutional resistance. The giving of a cathartic has complicated many a simple appendix and in exactly the same way the medical treatment of osteomyelitis and the resulting loss of time may convert a relatively simple condition into one which jeopardizes both life and limb.

The records of one New Orleans hospital for the last 6 years show that in 25 per cent of the cases the patients who were later proved to have the disease were admitted with no diagnosis at all, in 50 per cent the diagnosis was incorrect and in only 25 per cent was even a tentative diagnosis of osteomyelitis made in spite of the fact that all of the latter group exhibited fairly advanced stages of the disease. It is obvious that a condition which exhibits a 75 per cent error in diagnosis is not likely to result in a high percentage of cures.

The astonishing part of this situation is that the diagnosis is not difficult to make if only the possibility of the disease be borne in mind. The clinical picture is perfectly clear cut. Acute osteomyelitis occurs most often in young children and there seems to be a definite seasonal incidence. The summer incidence may be attributed to the prevalence then of minor skin infections, the fact that swimming is a popular amusement and the

likelihood that chilling may follow getting out of the water. The winter incidence is easily explained by the prevalence of tetanus and ordinary colds. It is admitted that the disease most often originates in either local skin infections or in infections of the cavities of the head. Traumatism is not an important consideration except in so far as it assists in the localization of the infection by providing a suitable field for the growth of the bacteria.

The first symptom is persistent localized pain near or in a joint. Then comes a chill, a temperature of 103 degrees F or higher, the usual manifestations of toxemia, and a definite leucocytosis. Such a syndrome is almost pathognomonic and it might be well to add that a negative X-ray examination at this stage paradoxically enough confirms the diagnosis, by the time gross changes can be demonstrated radiologically the disease is no longer in the early stage.

The localized pain should be enough to eliminate such diagnoses as intestinal upset and typhoid fever. Acute articular rheumatism and acute infectious arthritis offer more reasonable grounds for confusion but even here the differentiation should not be difficult. In the former disease there is a more gradual onset, less constitutional reaction, and a definite localization of the pain in the joint rather than merely in its neighborhood. Most important of all, unlike osteomyelitis, it is practically always a multiple affair involving several joints. In arthritis there is more joint fixation from muscle spasm and the swelling of the synovial joint membrane is in marked contrast to the practically negative physical finding of acute osteomyelitis in its first stages.

The disastrous consequences of an incorrect diagnosis are only too well known but they were recently brought home very strikingly to the writer by the fact that on his service at

Christy Hospital four patients were under treatment at the same time whose combined disability thanks to the type of treatment they had received initially totalled exactly one hundred years. From an economic standpoint if from no other such a waste should not be tolerated.

The necessity for early treatment is clear if the essential pathology of osteomyelitis be considered. It is primarily a metastatic or blood-borne disease originating elsewhere, has been pointed out in some minor skin infection or some infection of the cavities of the head. The septic infarct which is always small is arrested by the smallest capillaries of the body, those of the metaphyses of any of the long bones, and a true bone abscess forms. Unyielding bone cannot swell as can the soft tissues of the body, therefore bone inflammation can end in only one way, necrosis, from local anastomosis. If an avenue of escape is not opened the necrosis becomes more extensive, the resulting toxemia becomes more extreme, a terminal septicæmia may result, and the patient may lose his life as well as his limb. If he survives radical treatment is necessary, varying all the way from simple removal of the sequestrum to complete excision of the shaft of the bone.

The safety and simplicity of treatment in the initial stages of the disease is in marked contrast to this tragic picture. Limitation of the process can be achieved in practically every case by simply boring small holes in the cancellous bone structure with an ordinary carpenter's gimlet. Such a procedure done under aseptic precaution can do no possible harm even in the occasional case in which the diagnosis has been made incorrectly, while in the great majority of cases it will mean the preservation not only of function but often of life itself.

URBAN MAES

THE CHANGING CONCEPT OF THE TREATMENT OF SYPHILIS

FOR decades preceding the recognition of the spirochæta pallida by Schaudin and Hoffman and the synthesis of salvarsan by Ehrlich the treatment of syphilis was simple and uncomplicated. However since 1915 there has been a progressive advance in syphilotherapy. In a surgical practice approximately one syphilitic will be found among 10 or 12 patients; therefore the therapeutic trend of syphilis is of significance to the surgeon. Salvarsan now called arsphenamine controls the infectious lesions of syphilis rapidly and is essential in public health work. The more benign manifestations such as cutaneous or osseous gummæ likewise melt rapidly following its use but the more vital the organ involved the less complete is the recovery as for example the cardiovascular and central nervous systems. The drug relieves the symptoms and arrests the progress of syphilis when used in conjunction with other metals in from 75 to 80 per cent of cases and it is for the remainder of this group that new methods of treatment are sought.

The various modifications such as neoarsphenamine and sulpharsphenamine and the newer methods of administration have decided advantages in certain cases but have not proved arsphenamine to be a panacea. The original conception that one dose cures was discarded shortly after its advent and we now know that rarely will 100 doses cure when 10 or 30 have failed. In contrast it has been suggested that the intensive use of salvarsan in the early course of the disease predisposes to the development of neurosyphilis but accumulated evidence does not uphold this. As the shortcomings of arsphenamine were recognized newer remedies were sought to prevent the serious sequelæ of the disease.

Mercury by inunction or intramuscularly was revived and was used in conjunction with arsphenamine because it had been shown that mercury by mouth was wholly inadequate to control the disease. At the present time certain syphilographers resort only to the use of mercury by inunction during the early phase of the disease believing that the allergic influences that are stimulated by rubbing materially aid in control of the infection. The use of the iodides has always been advocated in the late form of the disease without knowledge however of what is accomplished or how.

Various other metals have been used in an effort to find a substitute to fulfill the faith originally placed in salvarsan and bismuth seemed most closely to approach the ideal. Its use intramuscularly does not supplant the arsphenamines but it has possibly a higher therapeutic efficiency than mercury. Continued experience with bismuth may reduce the enthusiasm attending its present use.

The intensive application of arsphenamine, mercury and iodides will cure approximately 75 per cent of patients with acute syphilis who follow the therapeutic regimen outlined for them. The time, energy and expense entailed in such a course of treatment is greater than the majority of young adults who are most prone to acquire the disease will expend in ridding themselves of the infection. Hence the frequency of clinical relapse in acute phases of the disease.

The period of latency varying from a few years to twenty years or more is dependent on the patient's resistance to the infection. In contrast the patient in whom paresis or syphilitic aortitis develops within three years after the infection is acquired lacks a defense reaction mechanism. In other words the type of soil on which the spirochæta pallida falls determines the crop of complications to be

reaped Unfortunately arsenamine influences this soil but slightly

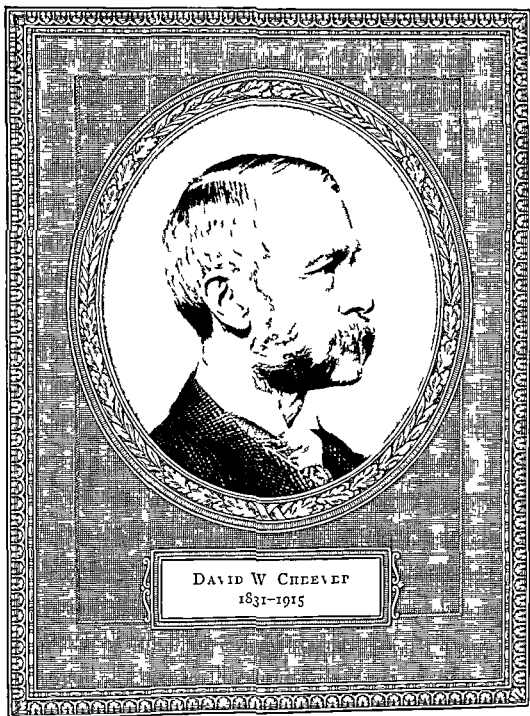
Wagner von Jauregg suggested the use of malarial fever in the treatment of general paresis because it had been known for many years that a patient with psychosis often improved after a period of fever. It has been shown by investigators in this country and in Europe that the production of fever has caused remission in about 40 per cent of cases of general paresis treated by this method. It should be borne in mind that a disease which produces symptoms by destruction of tissue will not clear up without leaving symptoms or scars and so the results of this new treatment should be graded by the economic good that is accomplished for the patients and not by the disappearance of the objective signs of the disease. To condemn the method because the Argyll Robertson pupils or the sensory changes or the deep reflexes remain unchanged is unfair. If the patient is restored to his former occupation or if more mental work permits him to support his family the method is worthy of further trial. The remission produced in 40 per cent of the patients treated compares favorably with the remissions that have occurred spontaneously for years in 1 per cent of patients with general paresis.

The mechanism by which a series of from twelve to fourteen attacks of malarial chills and fevers produces this remission is not understood. It has been suggested that the temperature itself has had a prominent part in the result or that the plasmodium vivax stimulated an immunity reaction against the spirocheta pallida. Assuming that both of these forces are essential nevertheless some

other influence must be at work and of these no doubt allergy or *umstimmung* is the outstanding factor.

The abortive cure of acute syphilis is occasionally unsuccessful. The results in the treatment of the secondary and latent forms are influenced by the patient's resistance and his application of the therapeutic measure suggested. The late visceral complications if recognized early are amenable to treatment in a high percentage of cases and the progress of the involvement of the nervous system may be arrested in proportion to the time at which treatment is started. If paresis exists remission may now be produced in 40 per cent of the cases by treatment with malarial fever. The modern syphilographers having been disappointed by some of the failures of arsenamine are redirecting their efforts to the stimulation of the individual defense mechanism rather than the continual flooding of the patient's blood by intravenous medication. In the fervor that attended the introduction of salvarsan followed by the misconception that since one dose would not cure perhaps 40 or 50 or more would the patient's mechanism of defense was forgotten and no doubt the belief that specific strains of the spirocheta pallida existed that exerted special affinity for nervous tissue or skin or viscera helped to swing the pendulum forcibly toward the concept of specific drugs and specific cures. The modern syphilographer is now anticipating the resistance mechanism and a means of stimulating it rather than endeavoring to overwhelm the spirochetemia by the intravenous injection of massive doses of arsenic and mercury.

PAUL A. O'LEARY



MASTER SURGEONS OF AMERICA

DAVID WILLIAMS CHEEVER

I AM glad to have the opportunity of presenting a biographical sketch of one of New England's great surgeons. When I first went to Boston as a young man in surgery I had the pleasure of attending Dr. Cheever's lectures and clinics where I learned lessons of enduring value. Dr. Cheever was a quiet modest man at once a brilliant operator and a precise, sound and conscientious surgeon. He made notable contributions to science which surgeons of this generation do well to study. His lectures which have been reprinted are as readable and as much to the point today as when they were first issued in 1894. They present in graphic language a sequence of events in pathological conditions that give insight not only into the character of disease and its effect on the patient but also its relation to surgical conditions in general. W. J. MAYO

THE Harvard Medical School and the science and art of surgery in New England were widely influenced during the last third of the nineteenth century by David Williams Cheever. He was of Puritan stock, descended through a line of ministers, teachers and doctors from Ezekiel Cheever who came from Canterbury, England in 1637, taught school for 70 years in Boston and vicinity and became one of the earliest and the most famous of the masters of the Public Latin School. Four of these ancestors were graduates of Harvard College and two were physicians—his grandfather Abijah Cheever of Boston a surgeon in the Revolutionary War and his father Charles Augustus Cheever who in a small New England town practiced medicine and surgery, attracted students and with them dissected cadavers in his attic, prepared skeletons and wax injections and did novel operations after reading descriptions in the scanty literature of the period and practicing on what material he could obtain.

The son was born in Portsmouth, New Hampshire, November 30, 1831. His life was that of the average New England boy. He remembered helping his father in surgical emergencies before the days of anesthesia. He graduated from Harvard College in 1852, still uncertain as to his career, since his father opposed medicine and he himself leaned toward a literary calling. In this doubt an opportunity to study and travel on the Continent presented itself and association with American medical students in their hospital visits brought the realization

that only medicine would satisfy him. He returned and plunged into the Harvard Medical School. Let those who insist on prolonged and rigid pre medical requirements take note that this man would probably have been lost to medicine if early decision had been necessary!

Picture a leading medical school of 1856. Attendance at three courses of lectures was required—each course consisting of five lectures a day for 4 months. The clinical work consisted of walking the wards of the Massachusetts General Hospital once a week in medicine and once in surgery and of attending a day of showy public operations. In the remaining 5 months the student attended extramural lectures or apprenticed himself to a practicing doctor or loved or worked at other things. The next year the same course of lectures was repeated and the next then a perfunctory examination and a degree. There was no laboratory work except in anatomy and that was not required but the earnest student could dissect the three parts assigned to him and bargain and dicker for more. Four of the eight professors attracted Cheever. Storer in obstetric, Clarke in materia medica, Henry J. Bigelow in surgery but pre-eminently Oliver Wendell Holmes in anatomy. To the latter—witty, brilliant, scholarly—he gave allegiance and he dissected and dissected and dissected. Holmes noticed him to his later advantage as we shall see.

Four opportunities each year for intern service were available—two as medical and two as surgical house pupils at the Massachusetts General Hospital. Appointment was not by examination but by solicitation of the trustees. Was it likely that a country boy without influence or friends would be chosen? Cheever thought not and his soul rebelled at possible rejection without trial. He apprenticed himself to the physician of the State Almshouse Hospital on an island in Boston Harbor for a year and a panorama of the needy destitute and criminal sick passed before him affording a mixture of general medicine, obstetrics, a little surgery, the care of children, contagious diseases, skin disease and venereal infections. He compounded medicines, improvised apparatus and was given a free hand with privilege of reference to his chief when he wished. It was good preparation for general practice.

So he hung out his modest shingle in Boston, waited 2 weeks for his first patient and collected four hundred dollars the first year. He kept the pot boiling by writing essays for the *Atlantic Monthly* and the *North American Review*. He accepted the position of physician to the small pox hospital during an epidemic and conducted it with as little as possible publicity among his patients and friends. And Oliver Wendell Holmes remembered the zealous dissector of the class of 1858 and when the demonstratorship of anatomy became vacant he offered it to him. Thus began 33 years of teaching in the Harvard Medical School.

For 8 years he labored hard at the demonstratorship making all of the lecture dissections for Holmes, revolutionizing the teaching in the dissecting room and

instituting competitive dissections and quizzes over the cadaver to quicken a dead subject. This constant work on the cadaver turned his mind to operative surgery which he diligently practiced but without much chance to apply it on the living as he had no hospital appointment. The Civil War found him with a wife and small children dependent on his daily work. He gave what service he could as acting assistant surgeon in Washington. Army medical inspectors detailed to protect the wounded from the attentions of unskilled and over confident surgeons apprised his work and offered him the control of a large hospital which had to be refused.

In 1864 when he was 33 years of age surgical opportunity knocked at his door and found him prepared. He was appointed surgeon to the new Boston City Hospital the youngest member of the staff. On June first the hospital opened its doors and on that day Cheever did the first operation in the theater under the dome. It was an excision of an extensive epithelioma of the lips and cheek. There was no antiseptis or asepsis no clinical thermometer no hypodermic syringe. But the frequent dressings were with chlorinated soda—a pretty good antiseptic! The silk ligature on the facial artery came away on the sixteenth day and the patient recovered.

There followed 50 years of service to the hospital as visiting surgeon and consultant which constituted the most important single factor in establishing its high reputation among similar institutions. Cheever had a high ideal of the obligations of the hospital clinician to the community and to the profession. The surgical staff under his leadership worked like demons to secure a place in the sun. He reported cases conducted voluntary clinics and ward visits for students and doctors and instituted Sunday conferences for all members of the staff. Competitive examination for house officers were introduced a much needed reform in Boston. Medical and surgical reports were issued edited for 5 years by Cheever and a medical associate. He called these the history of his professional life. It was difficult to attract students because the vested interests at a rival and already venerable hospital monopolized the teaching hours. But students are apt to be independent and seek knowledge wherever it may be obtained. The demonstrator became assistant professor of anatomy and gave courses in regional anatomy. The Czar of surgical Boston objected that such courses were the prerogative of the surgical department (though no one had thought of giving them before!) and stopped them with no light or courteous hand. Result resignation investigation by the Faculty reinstatement and promotion to the position of adjunct professor of clinical surgery with opportunities to give didactic lectures at the school clinical lectures at the hospital courses in regional anatomy and to have a seat in the Faculty. Thus always may humiliation come to him that cannot brook an honorable young rival!

Those were great days. The chair of clinical surgery was established in 1875 and Cheever was its first incumbent. He established the weekly conference, a clinical report by a student with references to the history and literature of the subject read before the assembled class and teachers. Henry J. Bigelow gave the didactic lectures in surgery. Cheever gave the clinical instruction. In 1888 on the resignation of Bigelow Cheever was appointed professor of surgery in Harvard University—the pinnacle of surgical preferment in New England. In 1893 at the age of 62 fearful lest the years might impair his efficiency without his knowledge and mindful of this calamity among some of his senior colleagues he resigned the professorship to which succeeded J. Collins Warren. As eminent professor he gave special instruction at the request of the students he continued at the City Hospital in the role of consultant and in 1903 at the age of 71 he did his last surgical operation.

During these years Cheever was a leader in New England medicine and his reputation was international. He originated some operations and introduced others to this community. He was the first in America to remove foreign bodies from the gullet by oesophagotomy and his monograph on the subject is a classic. Now the operation is nearly discarded since electrical illumination permits removal without incision. He did cesarean section—perhaps the first in New England. He had the first two consecutive successful ovariectomies in Boston before the days of antiseptics. He did plastic displacement of the upper jaw for removal of pharyngeal tumors; he removed the malignant tonsil by external incision; he worked hard to perfect Woods' operation for the radical cure of hernia. He was well known abroad—Ollier of Lyons corresponded with him about subperiosteal excision of long bones; Reginald Harrison of London about impermeable stricture; Holmes of St. George's Hospital about excision for coxalgia; Billroth of Vienna about the tonsil; John Wood of London about hernia. He became a foreign member of the Paris Society of Surgery.

It is hard for us to realize the handicaps under which this work was done. Antiseptics were imperfect. There was no antiseptics or asepsis; no catgut suture; no roentgen ray; no electrical illumination of cavities. Pyemia, septicemia, erysipelas and hospital gangrene stalked like spectres through hospital ward.

Then came Lister's beneficent gift and the whole aspect of surgery changed. As was said by a disciple, Lucas Championniere: "Surgery has only two periods: first that before Lister and second that since Lister." The new era found Cheever at the height of his powers and receptive as always to progressive ideas. He adopted Listerism—first the carbolic solution and wound irrigation, catgut ligatures and then the carbolic spray under which the surgeon worked until his head ached and his hands became numb and even his urine bloody from the renal irritation. Then asepsis supplemented antiseptics and the tremendous field of elective surgery, especially of the great body cavities was added to the older im-

perative work. Thus Cheever in his long life touched three great epochs as a youth he helped his father operate before anæsthesia in his early prime he struggled with wound infection before the days of Lister and in his maturity he enjoyed the security and certitude of healing conferred by Lister's gift to humanity.

His operative work was based on painstaking preliminary study and diagnosis well nigh perfect knowledge of anatomy familiarity with gross pathology and careful review beforehand of every step and anticipation of every complication. Let the event be what it might it found him ready. His manual dexterity was average he himself did not think he excelled as an operator. He was imperturbable steady unruffled but these qualities were due to iron control of a sensitive and high strung temperament. His policy was of wise preparedness. His foresight and forethought prevented mistakes inspired confidence and insured favorable results. His wide experience in general practice gave him breadth of view and depth of judgment.

Thirty three classes of Harvard medical students delighted in his teaching which after all was the field where he was unrivalled. Perhaps the genius of the old Master of the Public Latin School in Boston was dominant again in him. The demonstration of an anatomical dissection of an operation of a clinical problem or the conduct of a ward visit were to him prized opportunities to teach his precious art to others. The didactic lecture—now justly disparaged in its usual form was in his hands an important and acceptable instrument of teaching. It was carefully prepared beforehand but delivered extemporaneously in short crisp sentences of Anglo Saxon English wholly without theatrical effect but lucid comprehensive logical. Its principles and epigrammatic precepts remained fixed in the student's mind and guided his later practice. A young graduate versed in short hand took down the lectures as delivered and later with none but minor corrections they were published in book form as *Lectures in Surgery*. In medical education he staunchly supported President Charles W. Eliot in raising pre medical requirements establishing a graded four year course and developing clinical teaching.

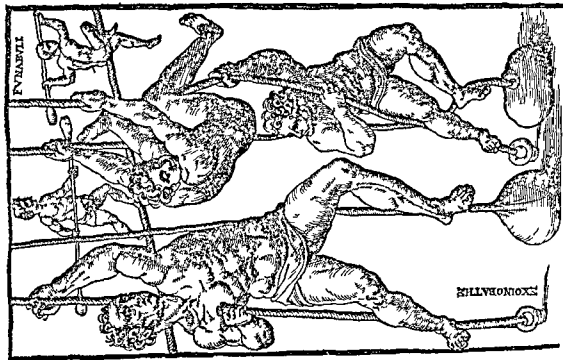
Cheever felt strongly the obligations of the physician to the community. His steady purpose is expressed in a reminiscent sentence from his pen. "I have tried to advance our profession. He wrote lectured published supported medical societies and actively abetted all measures looking toward the health of the community and the dignity and high standing of the medical profession. He fought quackery and medical imposture in all their forms. He helped dethrone the notorious coroner system in Massachusetts worked for privileged medical communications and frequently appeared before legislative bodies. He was president of most of the local medical organizations including the Massachusetts Medical Society and was the seventh president of the American Surgical Asso-

ciation in 1888. For 12 years he served on the board of overseers of Harvard College. He was a member of the American Academy of Art and Sciences and an honorary member of the Philadelphia College of Physicians and other societies and a foreign member of the Society of Surgery of Paris.

The personal impression made by Cheever was of a tall slender slightly stooping man with reserved and somewhat grave demeanor but with ready and responsive smile. Intellectual and moral vigor dwelt in a rather delicate physical tenement which he preserved by daily exercise and a mode of life temperate in everything but work. He revelled in the opportunity to dwell with Nature in his vacation and when fatigue and responsibility vanished he was light hearted and witty. With increasing leisure in later years he enjoyed travel visiting the scenes to which his reading had introduced him. He succeeded in medicine because he loved his profession above all else but his family circle he concentrated upon it during his active years all that he had of talent and energy. He loved especially the human elements of his calling—patients students nurses colleagues and though his manner was reserved and undemonstrative it did not long conceal his warmth of feeling from those about him. His character and personality inspired respect admiration and affection. His qualities and attributes and tastes were thoroughly human but perfectly disciplined to serve useful ends.

In the leisure of advancing years with undimmed faculties but failing physical powers he turned again to intimacy with Nature and to the company of favorite books. In 1911 two months before his death an honorary fellowship in the American College of Surgeons was conferred on him. Of this scene Warren wrote: "And when at the recent convocation the honorary degree was conferred upon him and I saw him for the last time in the robe of the order he seemed to me to have come into his own again. The sombre folds of the academic gown served as a fitting setting to the grave and intellectual features of the man and while during a pause in the proceedings arranged to allow him to retire he passed slowly down the aisle leaning upon a proffered arm his assembled colleagues rose as one man to do him honor as a recognized leader in their chosen profession."

DAVID CHEEVER



THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

BY ALFRED BROWN MD FACS OMAHA NEBRASKA

CONCERNING THE GYMNASTIC ART BY HIERONYMUS MERCURIALIS

FROM earliest times history affords many examples of the use of exercises both in military and civil life. The ancient athletic games of Greece, the gladiatorial and other contests of ancient Rome and the evidences of contests of athletic prowess among the eastern peoples all bear witness that from the Dawn of Civilization the training of the human body to withstand the physical stress of life had its place. That these exercises were graduated and carried on according to an orderly scheme with this idea in view is not too well recognized. Likewise the baths of ancient Greece and Rome are commonly looked upon as places of sybaritic enjoyment rather than as institutions of medical and surgical balneotherapy. In fact it has been of only recent date that the true value and place of physio- and balneotherapy have been generally recognized in surgical therapeutics.

Hieronymus Mercurialis made one of the first attempts to bring the efficacy of gymnastic procedures as curative measures before his profession in the sixteenth century. Mercurialis was not only a famous surgeon, holding in succession the professorial chairs at Padua and Bologna, but also was one of the most learned men of his century and interested largely in world affairs. At one period of his life he spent 7 years in the home of Cardinal Alessandro Farnese and employed much of this time in the study of the manners and customs of ancient peoples and later adapted the knowledge thus gained to the medical and surgical practices of his period.

In 1569 when 39 years of age he published the first edition of his *De Arte Gymnastica* and in 1573 the second edition appeared. In this year he was called in consultation to Vienna by the Emperor Maximilian II and as a natural consequence the volume is dedicated to him. The title page reads:

The Six Books of Hieronymus Mercurialis Concerning The Gymnastic Art In Which Are Diligently Explained the Kinds Places Manners Forms and All Ancient Exercises and Also Whatever Pertains To The Motions of the Human Body. Second Edition Enlarged and Embellished with Many Illustrations. A work not only medical but also very useful to all desirous of learning of ancient affairs and especially of the conservation of health (dedicated) to Maximilian II Emperor. In Venice at the house of Guinter 1573.

Following the usual dedication and laudatory

poems of the writer's friends comes a list of authors whose works Mercurialis has consulted. The first book is largely historical and explanatory. He begins with a sketch of the principles of medicine and lays down the dictum that there are two parts of medicine: the one curative, the other conservative. Gymnastics have to do with the latter part and he passes on to a description of the ancient gymnasia and baths, the plans of which are illustrated as well as described. Finally he ends this book with his division of ancient gymnastics into three types: the gymnastics of war, the gymnastics of medicine and the gymnastics of athletics and it is interesting to note that he prizes medical gymnastics as legitimate and condemns those of athletics as faulty or bad (*utusa seu alibi*). In the second book Mercurialis discusses the various types. He first tells what exercise is and how it differs from labor and simple motion. He describes exercises such as dancing and passing a ball from hand to hand and goes on to the more strenuous exercises such as football, wrestling, boxing and the athletic feats with the discus, etc. In the third book he considers the more truly medical principles of exercise—the benefits of walking, proper carriage of the body, the exercise of restraint, singing and laughing, swinging, riding and many other forms—not the least important of which is the discussion of the necessity for exercise for the bedridden or those who for other reasons are unable to work and get normal exercise in this way. In this class he includes those who must of necessity lead a sedentary life, mentioning in particular emperors, kings and princes. He speaks of the benefits of fishing, sailing, swimming and hunting.

The fourth book is in great part polemic and endeavors to confute the arguments of those on the one hand who condemn exercise as unnecessary in the healthy and on the other those who declare that exercise is necessary and beneficial to all irrespective of their physical condition. These two classes out of the way, he discusses the proper exercises for various types of persons: the well and the sick, the young and the old. And in the fifth and sixth books develops this theme in detail, prescribing the types of exercise indicated for the different conditions commonly encountered.

The work, even at the present day, is a mine of information both historically for its description of the ancient gymnasia and baths and its sound common sense advice as to the care of the body through properly guided exercise.

REVIEWS OF NEW BOOKS

I BELIEVE it was Murphy who said that the story of appendicitis should be rewritten each ten years. When one studies the mortality statistics of appendicitis of hospitals the country over the statement of Murphy can be amply justified as the mortality rate of this disease is entirely too high. Many competent surgeons have a higher mortality rate for appendicitis than with gall bladder or conservative stomach surgery. The reason is not alone a lack of skill in operative surgery or surgical judgment but the cases come to the surgeon too late—many times with a ruptured appendix with abscess or beginning diffuse peritonitis. The differential diagnosis in many instances is not by any means simple and clear cut. One has only to remember the cases of early central pneumonia or acute upper respiratory infections in children that give almost typical symptoms of appendicitis and in contrast the gangrenous appendix that gives virtually none of the classic symptoms of acute appendicitis. Relatively speaking no acute disease within the abdomen in its early stages is so frequently mistaken.

The answer is the story must be rewritten and it has been rewritten by Royster. In his recent excellent monograph the author brings to the profession in a most lucid manner the complete story of appendicitis both acute and chronic. The author attempts to give little if anything new but relates in an orderly fashion all the work that has been done the world over. One must be pardoned for enthusiasm shown for his excellent description of the differential diagnosis. Here lies the crux of the situation and he has covered it in a most instructive and complete manner. The chapter on complications is complete bringing to the reader's attention such conditions as liver infections, pyelophlebitis, subdiaphragmatic abscess, intestinal obstruction and the like.

Every practitioner of medicine should profit by reading this monograph. In fact the general practitioner will receive from it the greatest benefit as he is the man who sees 95 per cent of the early cases of acute appendicitis and must recognize them in order that prompt life saving measures may be adopted. It is pleasing to note his criticism of the practitioner who tends to wait and trust fearing to advise surgery. How often this procrastination has led to disaster.

The author incorporates an accurate description of the Ochsner treatment, its indications and method. It is common knowledge that there exists one might

say an almost universal misunderstanding as to what Ochsner meant when he advocated this method in 1907 and again in 1911. There is no question but that a wide dissemination of this fact also will save many lives throughout the world.

What is known today of the appendicitis diseases and accompanying pathology and complications and of proper treatment is clearly and concisely set forth in this most excellent monograph.

JOHN A. W. LEE

IN this little work on the diseases of newborn infants Burnet endeavors to save the student the hopeless task of gleanings a knowledge of the subject from the mass of literature that has accumulated. In this the author has been fairly successful. Perhaps he has devoted relatively too much space to the less common diseases but all in all the subjects are presented clearly and concisely and in a most readable manner.

The discussion of circumcision is superb. Says the author: "As a routine measure it cannot be too strongly condemned. The argument that it conduces to cleanliness and mitigates venereal infection is not a valid one. A freely movable prepuce is perfectly hygienic and is more ideal and more to be desired than the condition in which the glans is left entirely exposed. The operation is not to be undertaken without due consideration of the risks."

WILHELM F. LEE

IN this volume on *Brain Injuries of the Central Nervous System* one finds a large number of facts which in many instances directly contradict much of the vague and loose talk which has been handed down in much the same fashion as folklore. It is rather enlightening to note that these authors primarily interested in neurology are invading the obstetrician's field of clinical investigation and come to his defense. A great part of their work was made harder by the incompletely recorded histories and physical examinations of these patients. So it must be with a sense of obligation that the obstetrician read that the great mass of infantile palsies can no longer be lightly attributed to faulty obstetrical procedures. An excellent bibliography adds to the attractiveness of this monograph which represents a thorough study of a rather difficult subject matter.

LOY DAVIS

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AMERICAN COLLEGE OF SURGEONS

THE PARASITIC ORIGIN OF MAN¹

THE BIONOMICS OF ANIMAL REPRODUCTION IN RELATION TO TUMORS AND CANCERS

By SIR JOHN BLAND SUTTON Bt. 1 ACS LONDON

IT is a privilege to deliver this Memorial Oration. I accepted the invitation because I knew Doctor Murphy and appreciated his zeal for Surgery and the ability with which he practiced the art. His enthusiasm as a teacher and as an exponent of surgical pathology is well known and universally recognized. I met him for the first time in London in 1895 at a meeting of the British Medical Association. I was secretary to the Surgical Section and won his heart by finding a cadaver on which he could demonstrate to a group of surgeons his method of making an intestinal anastomosis with the aid of his ingenious button. I was delighted with his technical skill; our friendship was sealed with the button and this metallic device served to fix Murphy's memory in the minds of surgeons throughout the world. He was something more than a mere technician. His deep interest in surgical pathology is manifest throughout his famous *Clinics*. Knowing his interest in the surgery of tumors, the oration today is concerned with an aspect of the tumor question which I feel sure would have interested him.

The theory of the origin of man from lower animals finds its surest foundation in embryology and some remarkable observations and discoveries relating to tumors are concerned with this branch of biology.

The greatest discovery man ever made about himself was when von Baer in 1827 discovered with the aid of a microscope the human ovum. When ripe the ovum is a spherical cell just visible as a mere speck to the naked eye. The riddle of animal reproduction remained unsolved until Koelliker recognized the importance of the minute flagellate cells called spermatozoa. These remarkable cells were discovered by Hamm a pupil of Leeuwenhoek in 1677. They resemble protozoa and were called spermatozoa. For many years they were regarded as parasites of semen until Wagner and Koelliker in 1844 proved them to be histological elements of the testis. No one has

witnessed the union of a spermatozoon with a human ovum. It is a matter of inference from observations made on the eggs of starfishes and amphibians. In such creatures ova and spermatozoa mingle in the water and come into vital collision and the act of fertilization can be seen under conditions permitting accurate observation. Biologists who have studied the process of fertilization notice that when mature ova are brought into the vicinity of sperm the spermatozoa influenced by their presence make energetic efforts to reach them.

THE AQUATIC ORIGIN OF MAN

There is good evidence that man is derived from aquatic ancestors and the stages he passes through before becoming fit to be born indicate that the fetus in the womb lives as an aquatic parasite within its mother. When an ovum enters the uterus the overgrown uterine decidua on which it rests secretes a fluid for its nourishment. This fluid is aptly named by Teacher in a recent admirable research uterine milk. The ovum can flourish in this medium about 10 days. If the environment be favorable fertilization is effected by an active spermatozoon. The ovum in consequence of its union with the head of the spermatozoon becomes an oosperm or zygote and is quickly invested with delicate membranes. Of these the outer known as the chorion quickly becomes shaggy with protoplasmic bodies called chorionic villi. These villi erode the adjacent decidua and firmly embed the oosperm; they are in due course converted into a placenta—the respiratory organ of the fetus. Fluid accumulates in the amniotic cavity and in due course the embryo disports itself actively as an aquatic creature in its own amniotic pool.² In the early

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stage its skin is covered by a single layer of cells. Later this becomes double and the superficial layer is known as the epitrichium. About the eighth month of intra uterine life the epitrichium is cast off mixed with grease from the skin glands and the delicate woolly hairs known as lanugo. This soapy stuff is the vernix caseosa so conspicuous on the skin of the newborn child. The epitrichium persists on aquatic creatures such as frogs and salamanders and protects their skin from maceration. When the human fetus as an aquatic creature disports itself in the amniotic hydrosphere the epitrichium and vernix caseosa protect it from maceration. Occasionally the epitrichium persists and the fetus dies in such circumstances when discharged from the uterus it presents a weird appearance and is known as the harlequin fetus.

The human fetus is an aquatic mammal its blood being oxygenated by its mother's blood by means of the placenta. At birth it is expelled from the uterus discards the placenta and becomes a lung breathing creature.

Few things made a deeper impression on my mind than when as a child I realized that the tadpoles which emerged from the frog spawn in the ditch bordering my playground turned into frogs which jumped among the long grass in the paddock. This was my earliest lesson in embryology. When I became absorbed in anatomy and morphology the changes in the branchial bars as the aquatic tadpole transformed into an air breathing amphibian became more interesting especially on learning that in man their chief representatives are the delicate chain of ossicles—malleus, incus and stapes—in the tympanic cavity. It requires little imagination to realize that

the first landmark in the ascent of man was when the frog first found a voice and left the water, but true to its origin the frog must return to the water to spawn.

Recently Leathes in an admirable summary concludes that life consists in organic compounds continually refining themselves and that the sea is the native environment originally of all forms of life.¹ The importance of water is emphasized by the knowledge that the greater part of our bodies (two thirds) is water.

CHORIONIC VILLI

An ovum is propelled through the fallopian tube in about 3 days. Normally the life of the ovum is spent in the cavity of the uterus a suitable place for its reception and nourishment. When an ovum is attacked by a spermatozoon it

is changed from a placid into an active cell which burrows into the endometrium like a vigorous parasite. The initial effect of this invasion is the immediate arrest of menstruation. No one has suggested an explanation of this remarkable effect.

Thirty or forty days after fertilization the oöperm has undergone some remarkable changes. It has increased enormously and become a cyst with a thin delicate transparent wall containing a visible embryo and its outer wall is shaggy with delicate tufts known as chorionic villi. In the early stages the villi are devoid of blood vessels; they consist of an axis of delicate connective tissue supporting cells rich in protoplasm. These cells are peculiar in character and with the aid of a microscope are easily recognized by competent histologists. The chorionic villi are the chief cellular elements of the placenta. The cellular caps of the villi possess erosive powers which enable them to erode maternal tissues and blood vessels. Chorionic villi have become the subject of intense study. A century ago it was discovered that the curious product of conception known as the grape mole (Traubermole) is due to changes in the chorionic villi. Examples are preserved in most pathological museums. Scientific knowledge percolates slowly and this disease remained a curiosity until Saenger and Pfeiffer in 1889 independently described a malignant type of uterine tumor peculiar in structure which attacked parturient women. Subsequent investigations by many observers proved that such perversion is associated with the chorionic villi. It is now well known as chorionic cancer and its prime features are an exaggeration of the erosive properties of the villi; they penetrate the walls of the uterus and may invade the peritoneal cavity. When they erode blood vessels fragments of the villi are deported by the blood stream to the heart, lungs, bones, viscera and brain giving origin to secondary deposits and sometimes the patient succumbs with astonishing speed. Examples of the spontaneous disappearance of chorionic cancer have been reported. This betrays its alliance with the placenta which is a temporary organ.

The natural history of chorionic villi illustrates in a remarkable way the distinguishing features of the cancer cell: for example its power of independent growth, erosiveness and vitality which enable it to undergo dispersion and establish itself in parts of the body remote from its origin.

The natural history of the placenta is astonishing but facts have been gradually accumulating which increase our astonishment.

The placenta dominates the life of the fetus. The termination of its intra uterine life coincides

with that of the placenta and at the end of 280 days if the child is not expelled the fetal circulation stops the babe dies the placenta dies and is slowly absorbed. It is significant that a ripe placenta never becomes malignant. The villi—the immature elements—are the source of chorionic cancer.

The pathologist's interest does not end here.

OVARIAN DERMATOIDS—MISDIRECTED EMBRYOLOGIC ENERGY

When the wonderful effects which follow the vital collision of a spermatozoon with an ovum were unravelled by embryologists the spermatozoon seemed to be the essential factor in initiating developmental changes in the ovum. There are reasons for believing that this privilege is not peculiar to the tailed cell.

Ovarian dermoids are familiar to surgeons today but fifty years ago they were regarded as curious tumors found after death.

With the establishment of ovariectomy they were found to be common tumors but though common they are very remarkable. Nearly all organs normal to a fetus have been found in them except the reproductive gonads. Skin with all its special elements lanugo hair glands and nails brain tissue choroid plexus and spinal cord eyes teeth cartilage and bone trachea with mucous membrane and thyroid gland intestine and liver. The essential element is a skin covered lump which often resembles a mammary gland sometimes with a nipple surrounded with an areola. Sometimes a rudely shaped head and a stunted limb. These ill formed lumps known as embryomata represent an ovum which has developed without the stimulus of a spermatozoon.

While pathologists were puzzled by such occurrences Loeb induced the eggs of starfishes to segment by adding soda water to the sea water of an aquarium—shock fertilization. Later Batallion induced complete embryogenesis in the eggs of grass frogs by gently puncturing them with extremely thin metal or glass stylets dipped in frog's blood. It is now a common experiment in biological laboratories in spring time to produce fatherless frogs. These experiments have an important bearing on the origin of ovarian dermoids and support the opinion that they are due to the activity of ova.

The nature of ovarian dermoids has engrossed my attention for nearly 50 years. These tumors in some instances weigh nearly 50 pounds. Gradually I realized that the mass of grumous stuff which often forms the greater part of the tumor is excrementitious. The embryoma the essential

part of the tumor is skin covered and the skin sheds epidermis lanugo hair sebum etc. hour by hour day by day month by month and year by year until the accumulated rubbish makes the tumor conspicuous.

I have often wondered at the frequent presence of skin hair and teeth in dermoids and pondered on the absence of intestine. How blind have I been!

A peculiarity of the cubical cells lining the gastrointestinal track is the large amount of colloidal material which forms in them under pathological conditions. The biggest tumors which form in women are ovarian dermoids. Many years ago I urged that the membrane lining the honeycomb chambers of these huge cystic masses was mucous membrane. Gradually I became convinced that they are embryomata in which gastrointestinal epithelium is dominant.

In ovarian dermoids skin prevails and the accumulated rubbish—sebum epidermis lanugo and teeth—is detritus from the skin. This rubbish is the equivalent of the vernix caseosa of the uterine fetus.

In ovarian colloid cysts mucous membrane prevails. The accumulated stuff is pseudomucin furnished by the gastrointestinal epithelium of the embryo.

Between the extreme types there is every gradation of misdirected embryologic energy. These tumors arise in ova which develop independently of spermatozoa. When an embryoma is well organized the character of the dermoid is easily recognized and it is non-malignant. They are dangerous life by their bulk and septic infection to which they are liable.

Although I have spent much time in studying the minute structure of ovarian dermoids I have not detected in them any evidence of testicular tissue or chorionic villi. In 1905 Schlangenhauer discovered in a testicular dermoid tissue identical with chorionic villi. His observations have been confirmed by other histologists. In some instances the tissues closely resemble that of the grape mole.

It is noteworthy that examples of malignant testicular dermoids in which chorionic elements were detected have been associated with enlargement of the mammary glands. After ablation of the affected testis the mammary disturbance subsided.

It is worth mention that among the peculiar tumors which occur in the ovaries of adult women known as papillomatous cysts there is a variety in which the microscopic structure is like that of chorionic cancer. This variety is malignant and is disseminated by the blood stream. The second

any tumors erode bone with facility. In one example under my observation the secondary growths were in the superior mediastinum and bud like processes eroded the manubrium of the sternum and appeared as currant like nodules under the skin.

Papillomatous cysts of the ovaries are as a rule bilateral and occur in women between the twenty fifth and fiftieth years of life.

It is difficult to escape from this conclusion.

Pregnancy is an epitome of a parasite infection.

The fetus may be regarded as a tumor growing within its mother the consequence of an infection by a parasite—the spermatozoon. It is a strange eventful history. Copulation is the method of infection by which flagellate protozoa—spermatozoa—introduced into the female attack ripe ova in the uterine or the tubal passage and convert one or more into oosperms (zygotes). The oosperm embeds itself vigorously in the ripe decidua. The first effects of the infection are a local reaction—the arrest of menstruation and a constitutional response expressed by mammary activity and the secretion of milk and usually pigmentation of the skin localized to certain definite situations. The uterus in a marvellous manner adjusts itself to the growth of the fetal tumor and at the end of 80 days the death of the placenta coincides with labor and the expulsion of the child and its membranes. The fetus becomes an air breathing mammal leads an independent life becomes in due course mature and seeks opportunities for reproducing its kind.

PARTURITION

Childbirth is a natural operation and like a surgical operation has its risks and sequences. Of these the two most important are sepsis and cancer—one is immediate and the other deferred.

In spite of the brilliant results which ensued on the conquest of sepsis and the treatment of

wounds childbed fever persists. It is true that endemic puerperal fever disappeared when Listerian principles were applied but the sporadic form persists and will persist until parturition is conducted on the same strict methods as surgical operations. Take for example cesarean section. In 1860 this ancient operation had an enormous mortality. Today it is safer than normal delivery at term since surgeons have adopted aseptic methods—boiling instruments and ligature material—and especially wearing sterilized rubber gloves when conducting labor.

To reduce the risks of parturition to the level of a surgical operation parturient women should be treated on the same lines as a perspective surgical patient. *She should not be ashamed to wash the gate of birth with the same diligence and care as she washes her face.* Such a toilet is of the utmost value as a protection against postpartum sepsis.

Chronic ulcerating septic fissures in the wall of the birth canal are the lurking places of pathogenic germs and potential sources of uterine infection and cancer.

Science hath given a new commandment to doctors and midwives.

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We flounder in speculation concerning the causes of tumors and cancers as much as our predecessors floundered in ignorance of the factors concerned in animal reproduction. The microscope enabled us to recognize mammalian ova and spermatozoa and work out their intimate relations.

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THE RESPONSIBILITIES OF THE SURGEON TO THE PUBLIC

By GEORGE DAVID STEWART M.D. F.A.C.S. NEW YORK

THE discovery by Pasteur of the causes of many diseases and of most of the plagues that have afflicted mankind changed abruptly and forever the responsibilities of the medical profession to the patient individually and to the patient in mass—the public.

Under these changed conditions the profession in America has striven indefatigably and altruistically to fulfill their responsibilities but the opinion will be here expressed that much of this effort is wasted partly on account of the great number of agencies engaged in giving medical education to the public and the overlapping of their activities but also and chiefly because a large portion of the public cannot understand much of the information offered to them in this way and never will be able to understand it. Further it is believed that the best way of teaching the public is to bring an educated and sincere profession into contact with a shrewdly intelligent citizenry.

There are in America between 30 and 40 societies national in scope engaged in presenting to the public a certain amount of information regarding a single disease in which they are individually interested.

In addition every large city and most of the small ones have beside their hospitals municipal and private their dispensaries and public health departments many other medical or allied activities covering geographically the block, the parish or the town. Some of these function independently, many of them overlap to greater or lesser extent while some are in mortal conflict; thus it is not physically possible for prenatal clinics and birth control to flourish in the same soil. New York has besides its hospitals and dispensaries more than 30 local or city organizations and Chicago is blessed at least possessed with as many perhaps more.

Recognizing that from the multiplicity of these organizations and the variety of their interests there were certain to result overlapping and confusion the Council on Health and Public Instruction of the American Medical Association was selected by the societies to act as the single spokesman for the group, that the speaking might be with authority and not a confusion of tongues.

The machinery set up by this council established a press bureau which sent clippings and

other information on medical matters suitable for printing with the imprimatur of the council to 5000 newspapers (this was about 1913). There was also established a lecture bureau and medical lectures were furnished free on request of local societies. A library of lantern slides and other illustrations, radio talks and various other services and equipment could be had on demand.

The work done by the profession through the Council later changed into the Bureau has been enormous and of value no doubt but it has not met with complete success. At least it has not succeeded in becoming the universal spokesman for one of the societies referred to has recently obtained a million dollars in order to spread information in its own way about the disease in which it is interested and another is spending several millions a year in similar propaganda. There can be no criticism of the motives which inspire these efforts but surely it is a poor method of instruction that attempts to make specialists of the laity and an expensive method that can teach only one disease at a time.

The International Health Board reports 341 county health units in operation in 34 states for the year 1916. These county units carried to the poor and to those remote from large centers the advantages of up to date methods in medicine. The profession here bore a relation to the public similar to that of the family doctor. Of organizations like these that teach medicine to the public but only as incidental to the treatment of the public there can be no criticism. Lord Salisbury said a missionary must soon be followed by a gunboat but he never meant this to apply to medical missionaries.

THE EDUCATION OF THE LAITY

The public may be divided into four groups as far as their lay education is concerned. A large group receives only the so called elementary education which is compulsory, ends at 14 years of age and is now supplemented in many localities by part time continuing schools which carry the student approximately to his seventeenth year. A second group, smaller in number, receives the secondary education covered by the high school. To a third group less in number than the preceding but still very large for America has more colleges and more college graduates than any other country in the world is given the so called

higher education America has too a relatively large number of illiterates making a fourth group

Reading is not education and the largest group the first will depend largely on the public press for its knowledge of things medical excepting, of course the individuals who have a trusted family doctor. Many reputable newspapers and magazines exclude from their columns all medical information of doubtful authority and all advertisements except those strictly ethical. Further many publications have reputable doctors attached to their editorial forces. In spite of this much that is sensational and misleading finds its way into print.

The charlatan and quack have ready access to this sort of publicity and conscious of the fact that the public cannot discriminate are perfectly willing to enter into controversy which serve to advertise their wares while it utterly fails to classify them.

This in passing is an argument against the doctors advertising himself recently recommended by a well known writer in a reputable publication. The pretender in medicine or a sincere adherent of one of the cults has the same opportunity of advertising there is no tribunal to decide between him and the reputable profession except public opinion and public opinion is not technically well enough informed to make such a decision. The party willing to make the most extravagant claims promising the most to suffering often bewildered humanity has in such a contest an even chance of winning.

Another grouping of society not based on the lay education of the public but on the amount and kind of medical information it wants may be made. Old age is a condition youth seldom feels called on to contemplate. Similarly health arrogant and young or perhaps careless and old is rarely interested in discussions concerning disease. So long as the machine goes on without friction there is no or only a mild interest in the machine but let the evil days fall the man of intelligence seeks the aid of the best doctor he has heard of through his friends the other and he may even be one who has received the higher education flees to the mountains of promise with no rock of achievement beneath.

Beside those who are incapable of receiving and those who do not want medical information there is another large section of the community which wishes to be fooled. Mankind has always been looking for some means of cheating the jinx. For these medicine can possess potency only if its methods are mystical and its terminology turbid. Teach that attenuation increases power

it will be accepted eagerly as long as the reasons are not given or if given are not reasonable. Their credulity may be drawn upon without ever stopping at the boundaries of knowledge and there is no limit to the vasts of ignorance.

In that state of man's spiritual development when he regarded each object as possessed by an *animus* usually hostile it became necessary to convert it to friendliness. Soon there arose among the sons of men bright shining spirits who for a consideration would undertake these conversions. That the shining ones were the brightest of their tribe and that to them fell these tasks with their remuneration is not to be wondered at or made the subject of crabbed cavilling. This was a state perhaps as necessary in man's progress as was the polytheism of later and admittedly more civilized times. There are still many who prefer their medicine at the hands of the Shaman who expect tumors to be removed by sales that have a soothing action stones in the gall or urinary bladder to be dissolved by waters from Arbana and Pharpar and from monkeys not merely rejuvenation but resurrection.

To those best educated as education is commonly qualified the doctrines and tenets of the cults often make appeal when couched in terms unintelligible to most. Who knows that a consciousness of calm may not come to comfort the harassed soul and the suffering body through channels unrecognizable by what we commonly call intellect? An understanding doctor meets such cases with sympathy not intolerance. The Romans believed in bodily health as a form of religion holding that spiritual good might enter through the subtle gateways of the body. Every doctor knows that bodily functions are profoundly influenced through the far more delicately subtle currents of the mind.

Among educators today there is a growing conviction that education should never end but should go on all through life. This is an acknowledgment of the fact that there are certain subjects concerned closely with the texture and art of living that cannot be understood until experience with life has touched them and made their import and meaning clear. Aristotle believed that political science was not suitable for and could not be taught to the young. Newman said Read Horace if you will but don't expect to understand him until after you are 40 years of age.

In Denmark this continuing education is met by the special high schools which are open to everyone over 18 years of age. These originally established to keep alive the language and traditions of the race threatened by foreign aggression

and domination have been continued for the betterment of the people and because of the profound influence they have exercised on the moral, spiritual and even economical welfare of the Danish race. An agricultural people largely it might be supposed that the curricula of their schools would be in some measure at least concerned with farming. Such is not the case in stead literature, history and art are taught. By means of the first they can count the heart throbs of the world, through the second they learn what institutions man has founded to help him in his upward climb. From these studies held at convenient seasons they go back not away from their farms, conscious of the dignity of labor and contented with their lot.

It is this kind of broadening education rather than technical knowledge of medicine that is needed in America today.

The medical profession long ago recognized the need for a continuing education, a necessity sensed by almost no other profession in similar degree certainly by none. Academies of medicine, medical societies, clinical societies and assemblies everywhere bear witness to the desire of the medical profession to continue to learn all through life. Perhaps medicine is more dynamic than the other professions but if this implies a fault it contains a virtue for so is life dynamic and there can be neither life nor world without tradition or without change.

STANDING

In no profession are the standards of education so high as in medicine and this is due to efforts of the universities and the state medical licensing boards but mostly to the doctors themselves as represented by the American Medical Association. At the present time 95 per cent have a good general as well as a good professional training and according to the Commission on Medical Education in its preliminary report of January, 1917 for the first time the standards of medical education in America bear favorable comparison with those of other countries.

A high standard of education however does not connote a high standard of character or of ideals. The age is commercial and the public is demanding that its higher education be practical in character. A recent writer insists that the male students in the colleges not only do not ask for any cultural or liberal training but that they do not even know the meaning of these terms. Medical education particularly premedical is of course dependent on general education and takes from it both color and tone.

If this is true and if the profession wants the confidence of the public it must be understood that it cannot be had on a commercial basis but only on that of the soundest and highest ideals.

The French have long recognized in their system of education that the cardinal virtues of honesty and sobriety are taught by example and not by precept. It is obvious that to have advised the artful dodger that honesty is the best policy would not have succeeded but the example of an honest father or mother would have silently and surely accomplished that end.

While medical colleges then have scanned the antecedents as closely as they have the intellectual equipment of candidates for admission they have made no effort to teach in the school any of the cultural or humane or liberal subjects. It is of course impossible to lecture ethics into students at any age particularly is this true of medical students.

Still there could be no harm in injecting into the curricula overcrowded as it is, a short course e.g. on the history of medicine on great epochs and particularly on great men. Pasteur advised young men to reverence their masters and himself gave an example by strewing flowers on the grave of one of his beloved teachers every year on the anniversary of that teacher's death.

To learn with what difficulty new ideas are born and with what tenacity worn out discarded useless views cling to life is in itself an education in science and humility. At the present moment the colleges have before them the task of clearing out of the attic of the curriculum junk that has been collecting for years. Further because of the rapidity of discovery it will be necessary to recognize that one small head can never carry all there is to know and to make selections of the material most in demand and most useful. It was Herbert Spencer who pointed out that it might be useful once in a life time while arranging a railway journey to know the names of the cities of England, their distances apart and by what railways they might be reached but that compared to other information this was of little relative value and might be looked up with ease on the few occasions required.

The general reaction to the efforts of the medical profession to educate the public and to improve and elevate the standards of the profession is very interesting and tells an eloquent story of increasing (legal) state recognition of irregular practitioners of wider acceptance of many forms of medical service based on false interpretations of disease, of false theories of diagnoses and treatment of low educational standards and of the

absence of ideals. Under these conditions irregular practitioners according to the report of the Commission on Medical Education have increased 100 per cent in the last 15 years.

There is no question of course that certain broad facts may be taught indeed must be taught to the public e.g. that a lump in the breast of a woman should be investigated that an ulcer anywhere should not be suffered to long continue but there is no formidable array of such facts and the contention is that giving the public information through lectures and newspaper articles often leads them to believe that they themselves are versed in medicine or sends them to worship at the shrine of strange gods.

Let it be again emphasized that a society which teaches the public while treating them assumes the position and relationship of the family doctor.

On the other hand few of the clientele of the altruistic general practitioner ever desert him for

newer gods. Aware of his keen and sympathetic interest of the fact that he knows their systems both physical and moral they care little how much they understand of medicine but greatly how well they are under tood.

It is perhaps true that the general practitioner is disappearing. But 90 per cent of the demand on the practitioner (again quoting the report of the Commission on Medical Education) are for illnesses that cannot be treated on a community basis that is for problems of the individual. The general practitioner will reappear. He has been coming and going through the centuries.

When man is suffering perhaps fronting the great darkness there is in his heart a cry for understanding sympathy. Science changes but the emotions of the human heart are constant and men and women still weep over the tragedies of Iphigeneia but bear with fortitude the prediction of science that they will be superseded by a race of supermen.

AGENTS MODIFYING THE GERM PLASM

BY CLARENCE COOK HITTIL AB SD LL D ANN ARBOR

FOR centuries the attitude of the medical profession toward heredity has been a matter of great interest and of many hues and change.

As a general thing the physician or surgeon has been brought forcibly and repeatedly in contact with the striking phenomena of such processes as infection, contagion, immunity, and malnutrition. He has therefore been led to express a keen and constructive interest in the things and has aided notably in advancing human knowledge of the fundamental principles which they involve.

During the same period there was until 1900 no adequate laboratory method of testing the strength or nature of the process of inheritance in any given case.

In 1900 however Mendel's Law was rediscovered. At once there was a great increase in the amount and value of genetic research. In the years that have elapsed since then experimental genetics has advanced to a point where our knowledge of the physical basis of heredity is if anything more extensive than are our facts on many of the processes with which medical men have long been familiar and to which I have just referred.

So rapid has been this progress that many experimental geneticists bewildered by wealth of material and the great number of recorded results have been forced to specialize to some extent. This has resulted in the development of more or less isolated groups, all recognizing the same fundamental principles but so far along the road of fascination for their own material that they have lost a sense of proportion in interpreting their results.

An excellent example of what I mean to be found in Skyes work on the genetics of cancer. Having for almost a year been in a pathological and out of a genetic laboratory, she has collected with great patience an enormous number of pedigrees of families of mice in which neoplasms may or may not occur for the genetic interpretation of which her published works show repeatedly and consistently that he is unfitted. Her interpretation have however been swallowed whole by editors of medical journals and others of the profession who have direct contact with genetic laboratories may in some cases be even more antiquated than is her own. As a result there is bound at some time to be disillusionment and disappointment

and in all probability discredit of genetic methods entirely undererved by those methods which are in no way to blame.

It seems to me that geneticists are largely at fault for the general situation that has arisen and that they should make every effort to discuss with medical men all matters of general and mutual interest as early and as frequently as may be possible.

It is chiefly for this reason that I venture today to bring up the question of the germ plasm and the responsibility of the medical profession in using agents which may be able to modify the hereditary process in man.

In order to prevent the matter briefly I shall try to proceed from certain broad generalizations to more definite and concrete applications of genetic research to the problem of radiotherapy.

LABORATORY STUDIES IN GENETICS ARE A SAFE APPROACH TO HUMAN HEREDITY

a. *The nature of present records.* Two methods of collecting records on the process of heredity in man are at present employed. The commoner of the two may be described as *indirect*. In this case the investigator consults with members of a given family concerning the characteristics both physical and mental of other members of that family and record their opinions. It can easily be seen that this procedure introduces grave errors. The opinion of different individuals concerning any one member of the family will vary as will also the opinion given by one individual concerning various members of the family. This method however has given rise to most of the pedigrees and family histories which are published by students of human heredity. Not only is it used by the individual investigators but it forms a large part of the recorded cases on file at such centers of scientific research as the Eugenics Record Office of the Carnegie Institute of Washington.

The second method which may be described as *direct* depends upon records of hospital cases and clinical observations. The records are usually imperfect in that they fail to a certain by thorough examination the conditions found in living relative of the individual under observation. Much amplification then necessarily if records of this type are to have any value. Since the average space between human generations will be in the neighborhood of 25 or 30 years it is quite evident

that records would have to be kept in a consistent manner for a far longer period than has up to the present time elapsed since the establishment of adequate systems of individual record. A marked exception to the usual type of inadequate records is found in the case of the Institute for Biological Research at Johns Hopkins University. There every effort is being made to bring under direct observation all living relatives of any individual who serves as the starting point of an investigation. Since as above stated between 20 and 30 years must elapse before the complete life history of individuals of two generations can be obtained by this method we know that for purposes of present study even the best human records can not provide us with adequate information for a number of years.

b Records obtainable from laboratory animals. In many ways the records which can be obtained from experiments conducted in the laboratory are far superior to those referred to above. The accuracy of the records themselves are far greater since the individual animal is under direct observation throughout its life history. The speed of successive generations even in slow breeding animals like dogs is greatly increased in comparison to human beings. In the case of such forms as mice an average of between four and five generations a year means that results will be obtained about 120 times as fast as is the case with humans. Another factor of superiority possessed by laboratory forms is the great number of young which can be produced by a single pair of parents. This fact enables us to determine the extent of variation much more accurately than is possible in the extremely small families of human beings. A fourth factor of great importance is to be found in the controlled environment in which the animal is kept. By making the environmental factor essentially the same for all animal in a given experiment many of the sources of non-genetic variation occurring in humans are eliminated.

c Comparable nature of germ plasma in man and other animals. Detailed consideration of this fact will not be necessary since the essential similarity between the sex cells of man and other mammals and indeed between man and all other animals is recognized as a fundamental biological principle. It may be well however to point out very briefly certain of the facts.

Man in common with all other bisexual forms of animal life possesses a definite form which characterize the gonads of each sex. The morphological differences are carried even farther than in the form of the gonads and are reflected in the actual shape of the male and female sex

cells themselves. The generic resemblances between the human ova and ova of other animal or between the human sperm and the male sex cells of other lower forms is obvious and essentially universal. Similarity of structure within the sex cell itself is also striking. The general relation between nucleus and cytoplasm in the sex cell of all animals is as nearly constant a phenomenon as it is possible to find in experimental biology.

Physiologically also the comparison is a very close one. Thus in the process of maturation, ovulation and the various phenomena of the oestrous cycle as well as in the process of fertilization itself man and other mammals follow distinctly similar lines of physiological behavior. These facts clearly indicate that it is possible to draw a close analogy and in many cases a clear homology between man and lower forms.

EXPERIMENTAL EVIDENCE

a The direct effect of radio active substances on sex cells. One of the first and most striking series of experiments in this field was carried on by Oscar Hertwig and his children. Using as their material the sperm and eggs of frogs, toads and other animals in which fertilization can be easily observed outside of the body, these investigators tested the effects of methorium and various radioactive salts on the process of fertilization and early embryological growth. They showed clearly that the sex cells were damaged by the treatment employed. A light dose of exposure to the radioactive agent allowed the sex cell so exposed to function but produced as a result abnormal and monstrous embryos. A heavy dose given to the male sex cell allowed that cell to retain its motility and to initiate the process of fertilization without taking any part thereafter in determining the character of the offspring. The fact that such exposure produced different degrees of injury and that injured germ cells could function is important and will be referred to again.

The experience of early workers with X rays and radium showed that complete sterilization was frequently observed where the radioactive substance was allowed direct access to the gonads. This effect has been observed repeatedly in the case of rats by Hooker and in mice by Bag and the writer. Where sterilization is complete we may with fair certainty conclude that the sex cells have been killed or completely inactivated.

Of a somewhat similar nature but of more importance to clinical practitioners is the fact that by a temporary exposure of the same radio active agent followed by resumption of reproduction may be produced. The

experiences of a number of investigators agree in this matter without I believe any contradictory evidence. This of course would mean that for a time sex cells were killed or completely inactivated but that at the end of that period active sex cells were again formed.

Perhaps the discovery of most importance to the race is that abnormality of structure within the sex cell itself can be produced by exposure to X rays. The experiments of Mayr, Anderson, Muller and others have shown that the mechanism by which regular distribution of the chromatin material within the sex cells is normally brought about is frequently and fundamentally upset following exposure to X rays. Inasmuch as fundamental morphological and physiological abnormalities involving modification of sex sterility and in some cases early death of the individuals are produced by such unusual distribution of chromatin it is easy to see that a very important principle is involved. Not only do such changes in distribution of the chromosomes take place but the appearance of many morphological and physiological variations listed by the geneticist as mutations is produced. Leaving entirely out of consideration the imperfect evidence obtained from reported abnormalities in humans the work which Bigg and the writer have published dealing with mice is strongly suggestive of the occurrence of this phenomenon. The principle is further established by the recent work of Muller who because of the definite information which he possessed concerning his material (*Drosophila*) is in a position to procure incontrovertible evidence. Taken together the cases listed I believe seem beyond any doubt to establish the direct effects of radio active substances on sex cells.

DISCUSSION

From the above facts certain lines of reasoning may be followed with considerable benefit. First among these is the realization that any agent producing sterilization by killing or inactivating germ cells holds the potentiality for harm. In such cases it is clear that the effects of radio active substances upon the germ cell may be great enough to cause death, inactivity, malformation or internal upset of the sex cell. *There is no possible way of being sure that any treatments of the gonad with radio active substance which cause death or inactivity are not also producing in other sex cells of the same individual malformation or internal upset.* This fact is of primary importance and cannot be safely ignored.

The three grades which lead to death, inactivity or malformation of the sex cells are striking

and immediate in their effect. They would force themselves upon the medical profession eventually whether that profession desired to recognize them or not. The upset of the internal organization of the sex cell leading to genetic change is, however much more subtle its effects may not make themselves felt for two or more generations as was the case in the mice and in *Drosophila*. Because of the fact that the life of the individual medical man does not commonly span the entire life history of two complete generations the responsibility which he feels for remote descendants of those treated by him has not been as weighty as that felt for the patient himself or his immediate progeny. Only recently have the results of experimentation in the laboratory made it clear that in the case of treatment of the gonads of young people or those of reproductive age it is imperative that the medical practitioner should look beyond immediate results and shape his course of action in such a way as not only to benefit his particular patient but to insure the consideration of the remote descendants of that individual as well.

Certain criticism of this conservative point of view will undoubtedly be made. The use of radio therapy is increasing and its rewards are lucrative. Whole journals are partisan enough to concentrate on that particular field and results which are contrary to the popular desire—that such agents be considered mild and safe—are therefore not apt to be enthusiastically received. One of the most thoughtless and sinister suggestions is found in a recent paper by Dr M. I. Robinson in which the author cites Nurnberger and apparently agrees with him in the fact that if hereditary defects are produced which are Mendelian recessives the situation is harmless. He makes this assertion because inbreeding in humans is unimportant and relatively rare. Thus he considers that the chance of mating between two individuals who carry a recessive hereditary defect produced by irradiation is not worthy of consideration. What he really is advocating by this suggestion is that we should not worry until such individuals have thoroughly seeded the human race with a wide spread sprinkling of the defects in question. After such seeding however it would crop out sporadically in any locality in a manner entirely beyond our control. This would follow because every individual who carried such a trait would hand it on to approximately one half of his progeny even though it might not appear on the surface. Another criticism advanced by Robinson shows a lack of appreciation of physiological change during the life of a mammal which proves his almost

complete unsuitness to approach the matter from an experimental angle. It is of a type of comment altogether too common to those of the medical profession who have forgotten the foundations of scientific criticism and consists of his expectation that repetition of a given exposure of X ray to animals genetically different from those used in the first experiment would produce similar results to those first obtained. There is sufficient genetic variation between brothers and sisters in a single strain of mammals which have not been made genetically homogeneous by continued inbreeding so that one might fairly expect different results to follow an identical exposure to any radio active agent. This factor of uncertainty is multiplied many times in the case of the human material which in its very essence is highly variable. *The very fact that results of exposures to radio active substances do not always produce the same results is one of the reasons why in employing them medical practitioners should proceed with the utmost caution.* The use of rays on living material is not nearly so simple as is the use of other agents commonly employed in different types of therapy.

One other point worthy of emphasis and likely to cause confusion and one which is rarely recognized is the fact that the average medical practitioner has not grasped clearly the distinction between transmission and heredity. From a biological point of view the term hereditary applies is a misnomer. In this case there is involved definite transmission of an active principle in a relatively unchanged form from one generation to another. Heredity on the other hand means that in some way the composition or the organization of the sex cell itself has been altered in such a manner as to produce a reflection of that change in an altered structure or function of the animal arising

from that cell itself. It will be seen that constitutional tendency to susceptibility or resistance to various types of disease and the cause underlying constitutional abnormalities may be produced by a complex process of heredity although quite obviously their direct transmission would not be likely.

CONCLUSIONS

1. The germ plasma is modifiable by certain agents which affect it directly.

2. Radio active substances are among the most powerful of such agents.

3. Any agent which kills germ cells bears the possible power of producing inactivation malformation and genetic changes when used in decreasing amounts or strength of exposure.

4. The duty of medical men to future generations demands that

a. accurate systems of human records be established

b. that medical men keep up to date with advances in experimental genetics

c. that they use extreme caution in advocating the use of agents which may affect the germ plasma in young individuals or in individuals of reproductive age

d. that they discourage acceptance of results based on control data insufficient in number and inadequate. (In this respect the paper of Robinson before referred to in which the total experimental data consists of eight experiments each consisting of one rabbit is an outstanding example to be avoided.)

e. that they encourage the inclusion wherever possible of courses on experimental method and scientific criticism in the pre medical or medical curricula.

PROGRESS AND PROSPECT IN TREATMENT OF CANCER¹

By ROBERT B. GILLINOUGH, M.D., F.A.C.S., BOSTON

Ch m fth C m m t t h T t m t f M l g t D t h R d m J N y

THE Committee on the Treatment of Malignant Diseases with Radium and X-ray of which I have the honor to be chairman has attempted to make available for study a portion of that great mass of surgical material in this country which may aid in providing an answer to some of the disputed points in regard to the treatment of cancer in its more common situations.

Any attempt to review the literature it once makes evident the fact that published reports of end results in cancer cases from different clinics have been prepared under such different conditions that no combination of the figures presented is possible and the advantage of large numbers of cases in eliminating individual errors and exceptions is thereby lost. To overcome this difficulty the committee has attempted to do two things: (1) to establish a uniform method of classifying and recording cancer cases of the more important regions of the body, and (2) to establish criteria which could be accepted in every clinic in regard to the inclusion or omission of case records for consideration.

Such an effort has placed a great burden upon the individual representatives of the clinics participating in these investigations since all the hospital material for a specified period has to be reviewed and data secured and entered on the abstract cards in accordance with the committee's specifications.

To permit a minimum 5 year end result report the cases to be studied have been restricted to those of the calendar years 1918, 1919, and 1920. In the first investigation that of cancer of the cervix the period was from 1914 to 1919. In dealing with cases treated so long ago it was necessary furthermore to restrict the investigation to those clinics in which accurate records, adequate pathological service, and a complete follow up system were at that time in operation.

One preliminary report on the end results of treatment of cancer of the cervix was published in 1924 although at that time a full 5 years had not elapsed and a follow up of only 3 years could be obtained in the later cases.

At the present time two reports are in preparation: (1) the cervix cases are being carried to a minimum 5 year end result, and (2) material for a report on cancer of the breast on a minimum 5 year basis is being analyzed. Abstract cards for

three other forms of cancer have been prepared and the collection of records for cancer of the mouth and tongue, cancer of the rectum and cancer of the ovary has been begun. Similar cards for cancer of the colon and of the thyroid are in preparation.

To this very brief statement of the activities of the committee I should add my appreciation of the cordial cooperation which has been obtained on all sides in the arduous and time consuming labor of looking up and abstracting case records and in securing the necessary data on the end results, a burden which falls as a rule upon the younger members of the surgical fraternity, but one which is essential if accurate knowledge of the results of treatment is to be obtained.

That some such accurate statistics of the results of the different methods of treatment of cancer are greatly needed is evident today on every hand. The medical world universally accepts surgery and radiation as effective methods of treatment for cancer, and while a multitude of other methods has been advocated from time to time, some undoubtedly in all good faith and others unfortunately for less worthy motives, none of these other methods of treatment has as yet gained the confidence of the medical profession. Even as regards the value of surgery and radiation there are honest differences of opinion among those well qualified to judge, and it is to secure information for the better appraisal of these methods that the work of this committee has been undertaken.

The past few years have seen a number of advances in our knowledge of the biology and of the pathology of cancer, but the cause or causes are still unknown to us and the prospect of a specific remedy for the disease appears to be as far away as ever. We can go further and state that even if such a specific remedy were to be developed, as in the case of diphtheria or malaria, the problem would still be far from solution, for it is well known that even these diseases must be recognized in the early stages if the specific treatment is to be curative.

It is the difficulty of the recognition of the early case of cancer both by the patient and by his physician which is chiefly to blame for its high mortality. That surgery can cope with the

disease in its early stages is abundantly demonstrated in many regions. The fact that from 70 to 90 per cent of cases of breast cancer can be cured if operated upon during the early and local stage of the disease before the axillary lymph nodes are affected is sufficient evidence of the truth of this statement. Unfortunately such early and favorable cases include only about 25 per cent of the cases of breast cancer that enter our general hospital and the prospect of cure in the other 75 per cent becomes progressively less and less with the longer delay and the wider extension of the disease.

These are the facts which justify the campaign for the education of the public which is sponsored by The American Society for the Control of Cancer. An awakening of the public mind to the recognition of suggestive symptoms and to the danger of delay is undoubtedly the first consideration. This education alone however will not solve the problem. An educated public has a right to demand an educated medical profession and there are too many practitioners who still follow the wait and see policy in a doubtful case and thus permit the disease to extend from the favorable to the incurable stage before their very eyes.

The fact is that cancer today is not a one man job. It requires all the resources and all the professional talent of a large general hospital to deal with the disease in its many situations.

In my own state (Massachusetts) under an energetic public health commissioner supported by the legislature and by a governor who recognizes his responsibility for the health of the community as well as for its material welfare a system of twelve special cancer clinics is being organized in the larger general hospital scattered throughout the state. In each of these clinics a group of physicians is available who are competent to deal with cancer in all its situations and equipped with material resources to treat all stages of the disease. Such service may be rendered free to the poor patient or a moderate fee charged to those who are not in need of charity. The work of these clinics is co-ordinated with a central state cancer hospital of seventy-five beds which again is equipped with staff and personnel to deal with cancer in all its forms. We

believe that such facilities cannot fail to add to the prompt and effective treatment of the disease in Massachusetts.

With an educated public and with competent professional ability to deal with early and doubtful cases near at hand a great stride has been made in the utilization of our available resources against cancer. Unfortunately however there is room for improvement in the application of treatment both surgical and radiological in many cases. Thirty per cent of the cases of cancer of the breast coming to the Huntington Hospital for treatment of recurrence after operation are found upon investigation to have had performed originally an operation which falls far short in extent of the recognized limits of the radical operation for cancer of the breast. The reasons for the failure of the surgeon to give to his patients the chance every case should have of being cured by radical operation are hard to understand but I suspect that apathy or pessimism as to the probability of cure are the most frequent motives. Inadequate operations of this sort are being performed today in many of our hospitals and it is this fact as much as anything which justifies the segregation of the cancer material of the hospital in the hand of a group of men who are interested and willing to give their whole activity to the welfare of the cancer patient.

What is true of the surgical treatment of cancer is likewise true of its treatment by X-ray and radium. Not every patient obtains treatment from a radiologist whose greatest interest is in therapy. Many treatments are given with inadequate apparatus and many in a perfunctory manner that offers little advantage to the patient. Especially in regard to radiation therapy, it is to be noted the frequent lack of accurate records and of an effective follow-up system. It is again these facts which justify the special cancer service in the general hospital where the X-ray and radium therapist can join with the surgeon, the pathologist and the specialists in other branches of medicine in consultation and co-operation with a view to giving to each individual cancer patient the treatment or the combination of the method of treatment best suited to that individual case.

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CHRONIC ULCER OF THE DUODENUM AND STOMACH¹

By JOHN B. DEWITT, M.D., F.A.C.S., PHILADELPHIA

IN addition to chronic ulcer of the stomach I will include in this paper chronic duodenal ulcer. I have always considered these conditions most interesting in fact most fascinating. Although it is said that the question of treatment is not settled still I feel that the accomplishments of surgery in treating these lesions are as a rule most satisfactory. I believe that the gastro enterologist, the internist and certain surgeons who lack confidence in their work are to a great extent responsible for the doubt as to the good accomplished by operative as against medical treatment. Personally I can say the longer I practice surgery the more confidence I have in the surgical and the less in the medical treatment of chronic ulcer. The place which I give to the medical treatment of chronic ulcer is that before the diagnosis is definitely established. This statement is based on a study of the non perforative as well as the perforative ulcers on which I have operated. Nearly all of these patients have had medical treatment for years before they came to operation. It is a reflection on the profession that so many people who many times have been pronounced cured of ulcer die from perforation or haemorrhage from a chronic ulcer. It is claimed that haemorrhage from an acute ulcer can be cured under medical treatment. This may be true for a large number of cases but not for all for I have seen patients perish from haemorrhage from an acute ulcer. It is also

stated that recovery from hemorrhage due to chronic ulcer takes place in the majority of instances. But again I say this is not always so for I have seen a number of cases that were medically treated to death. What I have just said is neither to discountenance medical treatment nor unduly to praise surgical treatment but to give to each its proper merit. I have operated upon over 100 patients with perforated chronic ulcers, nearly all of whom had been treated medically for a number of years. In all such cases there was no question as to the presence of an ulcer as it was seen and palpated in the opened abdomen. I am not one who believes that the X ray is infallible in the recognition of ulcer. I have often questioned the pre operative diagnosis of ulcer on X ray examination and have found at operation chronic cholecystitis with surrounding adhesions or chronic appendicitis or chronic pancreatitis or in a very few instances visceroptosis.

The diagnosis of bleeding ulcer is by no means always a correct one. Confusion may be caused by bleeding from multiple abrasions of the gastric mucosa, ulcerating oesophageal varices, Banti's disease all of which goes to show that we must be on our guard.

In the last analysis the type of surgical treatment will depend upon the type of ulcer that is whether or not bleeding has occurred and whether or not the ulcer is attached to surrounding structures its location size the

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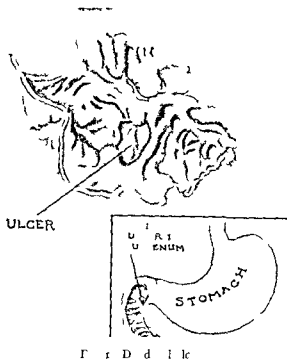


Fig 1 D d n l l (a n t r o w l l)

degree and character of the per ulcerous exudate the size and depth of the crater. Unless very small the crater is made out by apposing the wall of the viscus opposite the site of the ulcer with the ulcer site. With the finger tip the depression constituting the crater can then be readily felt.

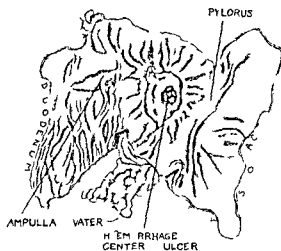


Fig 2 D d n l l (i n t r o w l l)

For the small ulcer on the anterior wall of the first portion of the duodenum a posterior gastro enterotomy is usually the operation of choice but if the operator is skilled and so prefers a Balfour cautery removal or excision of the ulcer and a posterior gastro enterotomy is ideal although some surgeons consider a gastroduodenostomy or a Finney pyloroplasty the better procedure. For bleeding ulcer of the duodenum if accessible cautery destruction or excision followed by posterior gastro enterotomy is the proper method. But when the

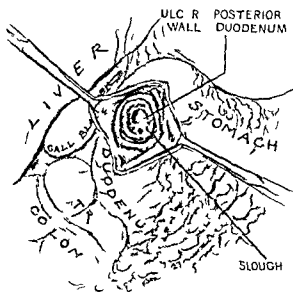


Fig 3 D d n l l (p o s t e r i o r w l l)

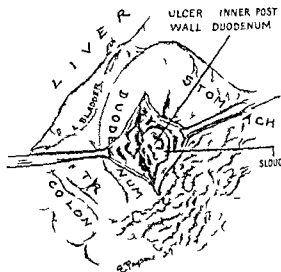


Fig 4 D d n l l (i n t r o w l l)

bleeding ulcer is not accessible for safe removal by cautery or excision or when the peri ulcerous exudate is too diffuse the operation should consist of amputation of the duodenum below the site of the ulcer and the exudate and removal of the pylorus. It is essential that along with the ulcer all of the peri ulcerous exudate be removed and also by careful examination that one make sure that there is not a second ulcer present. In the latter circumstances I prefer a subtotal gastrectomy although ordinarily I do not advocate subtotal gastrectomy except for gastric ulcer.

When the ulcer is on the posterior wall of the first portion of the duodenum its recognition is more difficult. Here we must see well and palpate well otherwise the ulcer will be missed. The recognition of exudate in the gastrohepatic or lesser omentum in juxtaposition to the duodenum is a signpost leading to the site of the ulcer which with the detection of the crater justifies the opening of the duodenum then as the margins of the incised walls of the duodenal wound are retracted the ulcer will be exposed. I place great value on the use of the Cameron light in these cases. In fact by this



Fig. 6 Gastric ulcer of the lesser curvature. Fig. 7 Chronic ulcer. Fig. 8 First part of the lesser curvature.

means I often am able to demonstrate the ulcer to the visitors in my clinic.

If the ulcer is located on the inner pancreatic wall of the second portion of the duodenum only a posterior gastroenterostomy is done but if it be a bleeding ulcer in addition to a



Fig. 7 Anterior anastomosis of the jejunum to resected stomach with a short loop.

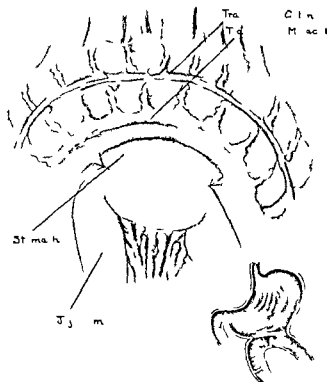


Fig. 8 Posterior gastroenterostomy.

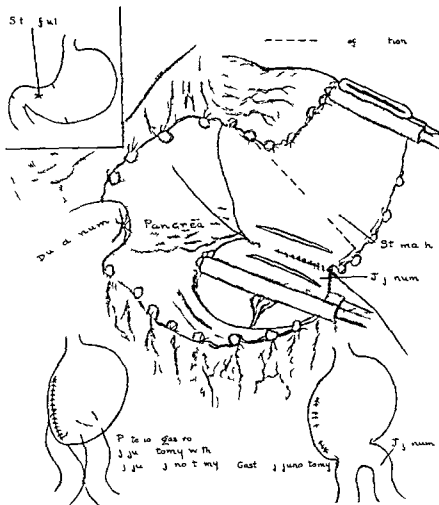


Fig. 9 Billroth II gastrectomy

posterior gastroenterostomy the duodenum should be opened the ulcer cauterized but no attempt should be made to remove the ulcer.

From what I have said of duodenal ulcer and what I shall say of gastric ulcer it will be seen that in the operative treatment of the duodenal ulcer the surgeon has a greater choice of methods than for the treatment of gastric ulcer.

For gastric ulcer with very few exceptions I advise subtotal gastrectomy. A very small ulcer with little or no per ulcerous exudate located on or near the lesser curvature on the anterior or posterior wall can be excised and nothing more need be done. But if the lesion is on the lesser curvature and has caused hour glass contraction I now on account of the danger of malignancy usually do a subtotal resec-

tion where formerly I made a sleeve resection. Although I have done sleeve resection in a large number of such cases with most satisfactory immediate as well as remote results I so firmly believe that gastric ulcer is frequently enough the forerunner of cancer that I do the subtotal resection as a greater safeguard against cancer formation. In doing a subtotal gastrectomy I find it easier to expose and ligate the coronary artery from behind than from above the stomach. This is accomplished by carrying the stomach well upward after it has been freed from the duodenum and the greater omentum. In ulcer of the cardiac end of the stomach posterior gastroenterostomy is the operation of choice.

The preferable type of subtotal resection is the Billroth II operation and if the loops of

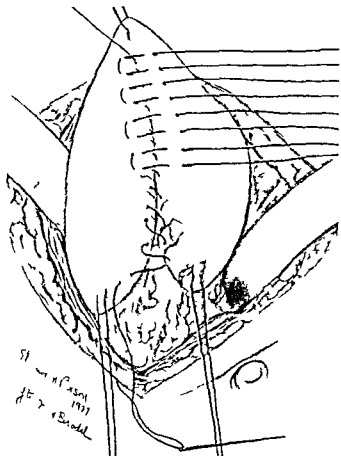


Fig 10a Finney pyloroplasty Step 1

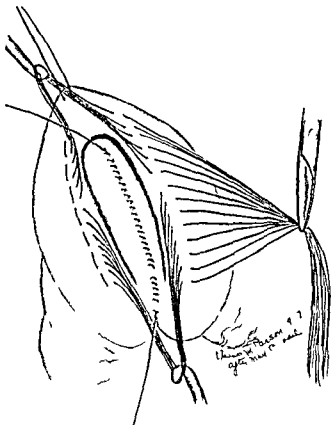


Fig 10b Finney pyloroplasty Step 2

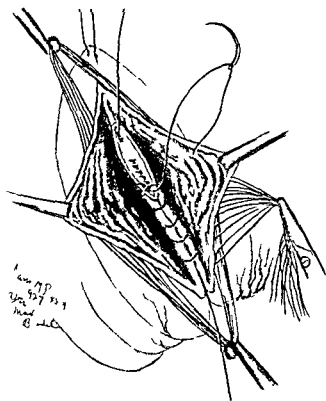


Fig 10c Finney pyloroplasty Step 3

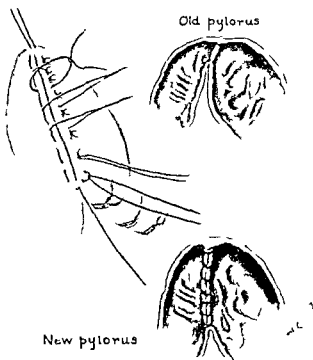
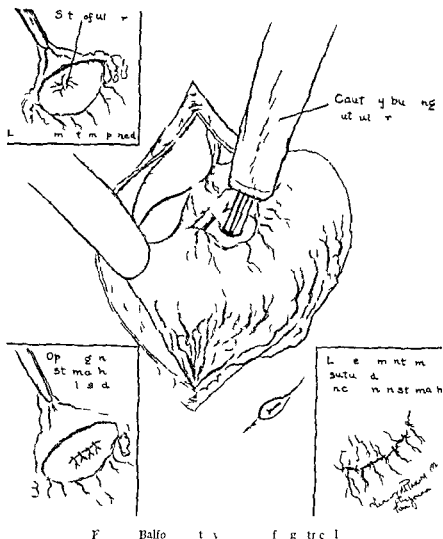


Fig 10d Finney pyloroplasty Step 4



F Balfour J G Trevelyan

small intestines are left long an entero enterostomy can be done. The Moynihan operation with a short anterior loop bringing the jejunum not far from its origin over the transverse

colon and anastomosing the end of the stomach to the side of the jejunum is probably easier than the Billroth II if a wide resection of the stomach has been made.

THE CONSIDERATION OF CONTOUR AS WELL AS FUNCTION IN OPERATIONS FOR ORGANIC ANKYLOSIS OF THE LOWER JAW¹

By VILLY P. BLAIR, M.D., F.A.C.S., St. Louis, Missouri
F mth D p tm t f g j W h gt U t j Sh l f M d

PREVIOUS to 1871 the common plan of treating ankylosis of the jaw was by forceful stretching or by excision of a section of bone from the angle or body. In 1858 an Englishman named George Murray Humphrey excised an enlarged condyle of the lower jaw. However the operation of excising one or both condyles for an ankylosis is usually credited to Bottini who published his report in 1872 (Fig 1). Before 1900 almost every conceivable type of operation for this condition had been reported even to removal of the jaw.

This subject is again brought to your attention not in the belief that anything really new will be presented but rather to emphasize certain factors the detailed descriptions of which are rather meager or lacking in the literature and also to bring out a few special points which will be emphasized by citing appropriate cases.

MECHANICS

Excluding inflammations tumors fractures and muscle spasm chronic limitations of the movement of the lower jaw may be due to (a) fibrous or bony changes of the joint itself (Figs 1 and 2) (b) change in the shape or bony fixation of the ramus (Figs 9d and e) (c) scars about the joint or in the cheek (Figs 6a and b Fig 9) (d) infringement of a neighboring bony process (Fig 5) (e) a combination of any of the above factors (Fig 9).

OPEN OPERATION VERSUS FORCEFUL MANIPULATION

Though occasional successful instances have been reported forceful dilation of a limited jaw opening of long standing which has developed gradually is seldom satisfactory and is not worth the effort involved (Fig 1). For permanent relief the cause of the fixation

must be eliminated or modified the more accurate the pre operative determination of this cause the better and simpler will be the correction. Halfway measures may give relief much more lasting than simple stretching but both are apt to be disappointing. Exposed scar bands should where possible be dissected out and replaced by a skin bearing flap rather than simple incision with anky Thiensch graft. In attempting correction by operation it is in most cases better practice to remove the upper part or almost all of the ramus rather than to try to reconstruct the joint. The latter is a nice operation but the former is much more apt to be successful.

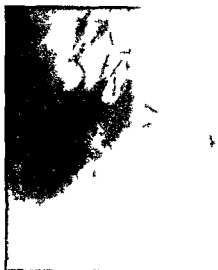
EXTERNAL DEFORMITY

When the ankylosis has existed during the growing period and is due to a fixation within the joint itself whether bony or fibrous there will be some shortening of both the ramus and body on the affected side with a corresponding backward and lateral displacement of the chin (Figs 3 18). If the fixation is unilateral and not complete the chin will further deviate to the affected side when an attempt is made to open the mouth. This latter point may be helpful in determining which joint is fixed.

INCREASED ANTEROPOSTERIOR BREADTH OF THE RAMUS

If the limitation of movement is primarily due to scar bands that fix the lower to the upper jaw the ramus may become abnormally broad from before backward. This might possibly be due to a failure of the anterior border of the ramus to be absorbed as is ordinarily concurrent with the normal growth of the lower jaw. In addition to this abnormal breadth the two jaws may be found fixed to each other by bony union (Figs 9d and e). If the injury to the soft tissues happens after growth is completed the subsequent scarring does not seem to cause these bone distortions.

S w f g t d l f s o d s s p t l w th
th t dec d s g c j & Ob t 9 4 36- 5
P t t bef th Am S l oc t M 6 9 5



F

(Fig 11) Elimination of the scars with restoration of the soft tissues soon after injury may prevent this distorting growth of the bones (Fig 12a)

RELATION OF CONDYLE TO NORMAL MOVEMENT

While the presence of a normal condyle is essential to the normal development of the mandible and of the temporo mandibular joint and to normal strength and stability and mobility of the mandible still neither condyle is essential to useful function (Figs 13a and b) The writer's own conclusion is that the lower jaw is hung in such a perfect muscular balance that both condyles can



F



Fig b



F c

F d

be removed and where desired the jaw can be moved forward without seriously crippling function (Figs 14 and 15) This latter point probably explains the universal success in the restoration of this joint obtained by the simple excision of sufficient bone with or without complicated efforts to furnish a substitute for the necessary joint surface The writer has always attempted to interpose a fatty flap or superficial temporal fascia not with the idea of placing a barrier between the bony surfaces but to help fill the dead space that is left after removing the condyle (Fig 7)

CORRECTION OF THE EXTERNAL DEFORMITY

That a plan should be made for the improvement of contour as well as for the restoration of movement is the chief aim of this paper (Figs 6 to 15) Correction or improvement in appearance may be accomplished by one or a combination of several of the following procedures



F 3 S symphy S is
p unt t whi h symphy is would
m f t ot t th midone
with l c t rr ws ad
b h w d ct of m m t



Fig 4a



Fig 4b



Fig 4c

1 After the fixed joint is freed the affected side of the mandible may be dragged forward and fixed in this position until the tendency to recede is overcome (Figs 5 7 16 17 18). At first the fixation is made by interdental wiring but later the pull of a rubber band may be used. In unilateral ankylosis with a receding mandible it may be necessary to section ramus of opposite side to get best attainable position of body of jaw (Fig 4).

2 The receding chin can be built out by means of an implantation of costal cartilage (Figs 7 15 17 18).

3 The facial obliquity remaining after fixing the jaw bone in its new position can be rendered less noticeable by shifting the soft tissues of the chin laterally by filling along the flat side of the jaw with cartilage or by a combination of these (Figs 17a d and e).

TYPES OF CASES AND METHODS OF TREATMENT

Bony overgrowths about the joint—double resection and partial open bite. A blow on the face (Fig 1) may be followed by an overgrowth of one or both condyles or of the neck and there may be an associated downward growth from the temporal bone. Any of these may distort the joint and limit movement without causing a true ankylosis. It was probably such a case that was originally operated upon by Humphrey. Figure 1 a roentgenogram taken in May 1925 shows such an overgrowth. In 1931 at the age of 10 years the patient was referred to us by Dr C H Clay with a history of previous good health but at the age of 8 years she

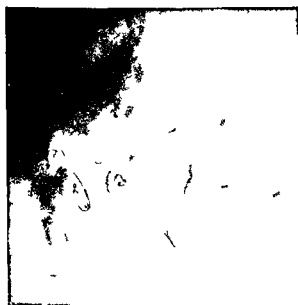


Fig 5



Fig 6a

Fig 6b



1



6



7c



13a



13b

has fallen half a foot into the face. Three months before the case she could not open her mouth freely and at the time the symphysis was slightly to the right, the right lower cuspid being slightly behind the upper. The opening between upper and lower lateral incisors a 13 millimeter. The limit of movement was not sharply defined but could be fully stretched. In March 1933 the opening was stretched to centimeters and it was 2 millimeters 3 days after this operation. The child was kept under observation for months with no decrease in the opening. She returned in March 1934 with only a suggestion of movement. Both joints were then excised including the condyles and the overhanging bone that arose from around the outer wall of the glenoid fossa. The mandible was dragged forward and fixed for 3 days at which time the interdental wiring was removed. It was found that while movement was not pathological (Fig. 13) because of the elevation of the occlusal surface of the molars there was a separation of the incisor teeth which would require further treatment.

This is the second case of ours in which after the resection of both joints at once there was a partial opening in the incisor region and both followed easily removal of the dental fixation. If the immediate restretching of the lip and the retraction of the teeth is not immediately corrected by sectioning the ramus on each side below the site of the previous operation and then fixing the jaw in occlusion until bony union occurs.

Figure 13 shows the results of the operation. Figures 13a and b. We have X-ray pictures of a child 3 years old who had gonorrhea at birth resulting in ankylosis of the left side. Figure 13a shows the left ramus and damaged joint. Notice that the developing sixth year molar is the ramus and completely distal to the fifth year molar in the upper jaw. On this side the ramus in the roentgenogram measured only 5 centimeters in length while in Figure 13b the uninvolved side the relationship between the upper and lower sixth year molars is about natural and the ramus measured 6 centimeters.



Fig 9a



Fig 9b



Fig 9c



Fig 9d

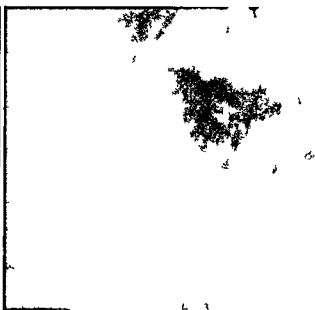
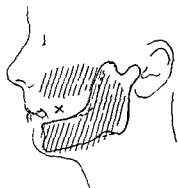


Fig 9e

Direction of rotation in bringing the jaw forward
 Figure 3 is a diagrammatic representation of a lower jaw short from before backward on the left side on account of an ankylosis of the left joint which occurred during the growing period. After fixation was relieved we were able to bring the symphysis forward and to the right by rotating the bone around the center which is at the right condyle. The left ramus will move in the direction of the arrow *a* the symphysis in the direction of the arrow *b*. Note that the symphysis moves forward as well as toward the midline.

Section of the ramus to bring forward the body
 The patient shown in Figures 9a, b and c had scarlet fever and suppuration around the left temporal mandibular joint at 16 years. At 16 years she had extreme recession of the chin and inability to open the mouth. From lack of appreciation of the true mechanics of the condition the writer in February, 1908, cut both ramus in two and dragged the body forward. This brought the chin into a better position but did not permanently cure the ankylosis. The result of this is shown in Figure 9a which was taken late in 1908. *A* marks the posterior border



Indicate limit of the shadow

/// A graft

X Original depth that was placed in the

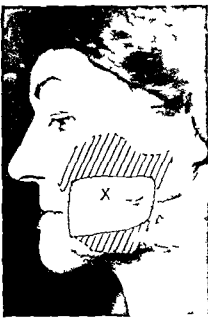
Outline of mandible shows reduced height and not horizontal

Approximate of a normal mandible

F



F



F b



Fig 1a



1

of the upper part of the ramus dragged obliquely forward as the body was advanced. It shows the ramus below the bone cut. The bone cut itself is indicated by the light line between these two. The resultant false joint later became fixed and the left condyle was therefore removed.

The proper procedure in this case would have been at the original operation to have removed the left condyle and cut through the right ramus. This would have restored movement and at the same time permitted bringing forward the jaw.

Figure 4b was taken in 1911 and Figure 4c in 1923. A study of the relations of the two last molars will show there was a slight recession of this side of the jaw after removing the condyle. The wire and nail shown at the symphysis in Figure 4a are in cartilage implant made in September 1908 and in spite of some immediate suppuration the cartilage has remained in place ever since. This type of cartilage fixation is not used any longer.

Limitation of movement due partially to an overdeveloped styloid process that prevented normal lateral excursion of the angle. Figure 5 is a roentgenogram of a 5 year old patient who was crushed under a falling bale of hay and generally injured between the ages of 11 and 12 years. It was noticed at that time she could not open her mouth freely. Examination showed that the excursion of the lower jaw was limited and from that time on the chin became actively more receding and the downward excursion of the lower jaw lessened. When she consulted the patient was 21 years old, delicate and very thin. The mandible was undeveloped and the greatest possible vertical opening between the upper and lower incisor teeth was one eighth of an inch. Because of the backward displacement of the jaw the lower incisors were one fourth inch behind the upper incisors which with the one eighth inch opening gave

a possible lateral excursion of the teeth in the course of development. It is probable that this did not appear until the patient was 21 years old. She presented the condition that the lower jaw was free until the age of 14 years. It was one eighth of an inch open. During this time the right condyle traveled forward and the lower jaw remained in full opening. The left condyle remained apparently fixed. It was not until more than 10 years after the operation could be explained that the reason that there was a loose fibrous ankylousity at the joint and on that side the angle prevented from moving backward by striking some firm object. A poor X-ray picture, the best available at this time failed to throw light on this point.

The indication in this case were to give free opening of the mouth, to establish a better occlusion of the teeth and to improve the profile by carrying the chin forward and holding it there. The ramus were sawed transversely on both sides and the body of the jaw brought forward until the lower incisors were a little in front of the upper and the chin

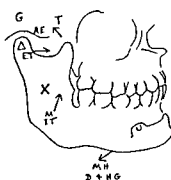
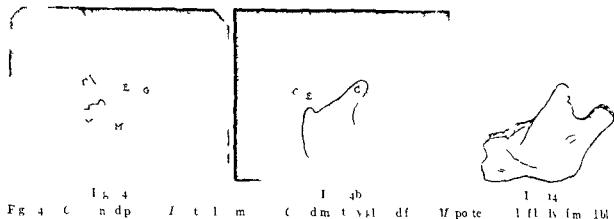


Fig 13a



Fig 13b



symmetrical placed. It was wired in the position in 4 weeks the union was examined and found not to be strong, so the teeth were rewired for 6 weeks more. When the wires were removed from the teeth it was found that the mouth opened freely one half inch and that the limit of movement was some yielding structure. Examination 6 weeks later showed that the lateral movements were normal and the possible opening between the incisors was seven eighths of an inch, which is sufficient for good function.

A good roentgenogram taken some years after the operation showed that the styloid process on the left side was almost the size of her little finger and at full opening abutted against the inner side of the angle of the jaw. It also showed a change about the left joint that suggested at least a fibrous ankylosis. This corresponded with the original deductions. When the body was moved forward a space was obtained between the angle and the styloid process which gave room for the angle to travel backward and approach normal movement.

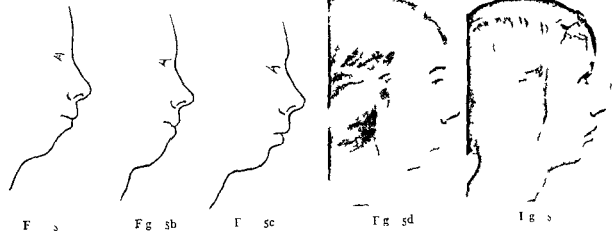
Another patient had an arthritic fixation of the cervical spine with the head bent slightly forward but even after the resection of both condyles the excursions of the mandible as still quite limited by the chin striking against the thyroid cartilage.

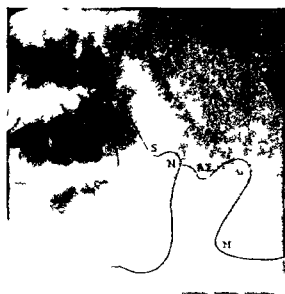
But the joint present in the place of the condyles the jaw was allowed to rest and an interlocking occlusion established the normal position of the body of the jaw (Figs 6a and b).

Figure 6a shows a child 3 years of age with a close fibrous ankylosis of both joints with a good deal of particular swelling all due to an early infection of some kind. At operation both condyles were resected but on account of the scarring in the soft parts it was impossible to move the body of the jaw forward.

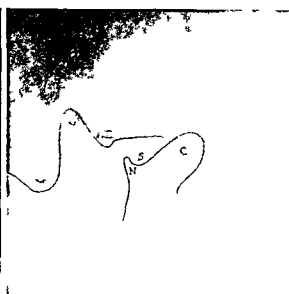
Figure 6b shows the same child 7 years later at which time she had a functional opening of the mouth.

Figure 7a is a child with a bilateral ankylosis. At the age of 6 years the patient (Figs 7a, b, and c) had a tooth infection and necrosis of the jaw on the right side. At 4 years when he came for treatment the most noticeable points were late al prominence of the body of the jaw toward the ankylosed side with corresponding flattening on the opposite side, deviation of the chin to the right and no forward movement of the affected side with obliquity of the mouth slit as compared with a line drawn through the palpebral fissures. The patient corrects on here





Fi 13f



Fi 13g

Fi 13f M mandibular process G glenoid fossa E articular eminence N rudimentary neck S sigmoid notch C coronoid process

shown was made by removing most of the right ramus and rotating the jaw bone to the left shifting the soft tissues of the chin still farther to the left and implanting a cartilage. In this the first case in which we attempted to move the soft tissues on the bone the chin was brought to correspond almost with the axis of the nose as shown in Figure 13. A more acceptable result would possibly have been obtained if the chin had been brought nearer to a vertical line dropped from the mid point between the brows at right angles to the axis of the palpebral fissures as was done in Figure 13c.

Figure 13c shows the large amount of the ramus that was removed to permit bringing forward the right side of the mandible. In the case shown in Figure 17 it was necessary to remove a still larger part of the ramus including that part which held the roots of the third molar before the mandible would clear the upper molar teeth. This large removal of the ramus seems to cause no functional inconvenience in a single resection but I believe it not permissible in a double ankylosis. In the latter case I believe it is desirable to retain the coronoid process and temporal muscles.

Lateral deviation. A child 11 years old (Figs 8a and b) who at 4 1/2 years had meningitis following which partial ankylosis gradually developed. Figure 8a shows the full extent of the opening when he came for operation. Figure 8b the possible opening 16 days after removal of the condyle and upper half of the left ramus but this opening should increase considerably in the next 3 months. The point brought out in this illustration is that the tendency when the mouth is opened for the chin to deviate to the resected side still persists.

Scar fixation—late results. A woman 38 years of age (Figs 9a, b and c) was referred to us by Dr W. C. Drummond. At 11 years she had probably

a noma and lost part of the cheek, left upper lip lining of the cheek and part of the left upper jaw bone when it healed she could not open her mouth. Figure 9a shows condition February 1918 with mouth open to the fullest extent 4 millimeters between upper and lower incisors. Figure 9b shows the extent of the opening after the removing of the upper end of the left ramus the removing of the cheek scars and the replacing of lining and external cheek tissues with flap from forehead. The mouth would open December 1, 1924, centimeters between incisors but this has increased since. Figures 9b and c were taken February 13, 1925. Figure 9d shows a normal joint but a somewhat wide ramus and coronoid after 2 1/2 years of almost complete fixation. Figure 9c shows the left the injured side.



Fig 16a

Fig 16b



Fig 6



Fig 6d

with only relative growth changes about the joint itself but with tremendous widening of the ramus and posterior part of the body. Originally the bony mass at the outer border of ramus or of the posterior part of the body had acquired bony union with the maxilla but this was chiseled through at the original operation in 1908 by Dr A O Fisher and had not reunited. The joint change shown on this side in this figure were a relatively small condyle and a very deep narrow glenoid fossa with a correspondingly high articular eminence. In the note on the 1918 operation it is stated that after cutting the scars and cutting the bony union between the two jaws the mouth could be forcefully opened 3 centimeter and was blocked in this position but in 1924 after cutting all the reunited scar bands we were not able to open the mouth until the joint and upper half of the ramus were removed.

Scar fixation—late results. In Figure 10 we have the photograph of a woman referred by Dr H R Shands who in 1923 was 22 years of age. At 13 following typhoid fever she had a noma which destroyed the lining and considerable of the surface of the left cheek. Following this she could not open her mouth. Some time later the lining scar had been removed and the cheek lined with a flap turned from the neck but she stated it did not relieve the fixation. When first seen by us March 12, 1923 she had an opening between the incisors of 6 millimeters. Fixation apparently was due to a scar band in front of the cheek lining that had been obtained from the neck at the previous operation. However a functional opening was not obtained until the abnormally wide ramus was removed and the cheek lining pieced out and the buccal and labial sulci were restored by means of thick Thiersch grafts inserted on wax forms. A shadow the area lined by the original neck flap. The shaded area shows the amount of lining that was obtained from the Thiersch grafts but there is always considerable contraction

of these thin free grafts for which provision has been made. The dotted line shows the profile of jaw bone bringing out the increased anteroposterior width of the ramus.

The lower lip was subsequently raised by a flap thrown under the chin. Still further correction was done later by Dr J E Johnson of Memphis.

Scar fixation—later results. Figure 11 shows a woman 36 years old referred by Dr Royal Wight. Seven years previously following the extraction of an infected tooth in the acute stage of the inflammation she had a necrosis of the bones and considerable loss of the soft tissue. The edentulous gums were held almost in contact by the cheek scar. Compare with Figure 10b and notice in Figure 11a that the distance from nose to chin is much shorter and besides the hole in the cheek and its scarring the corner of the mouth is drawn up and back. In this case as the injury occurred after the bones had ceased to grow there was no great deformity of the ramus and joint and the correction consisted only in the release of the scars and the replacement of the destroyed soft tissues. This was done by first throwing a double pedicle flap from the neck to line and cover the cheek and then later by restoring the upper and lower sulci by Thiersch grafts put in on wax forms. The oblong area in Figure 11b indicates the position of the lining flap derived from the neck. The dotted lines outline the wax forms and the striped surface the extent of the area covered with the inlay Thiersch grafts. These two procedures enabled her to open the mouth sufficiently for function and allow for complete upper and lower dentures. Notice the difference in outline of lips and chin as shown in Figure 11a.

Debridement of cheek scars causing staphylococci. Figures 12 and 13 show a child of 8 years in whom after a gangrenous stomatitis at 5 years and several ineffective

Ob: 0 5 1 f h l g f h m h s g c y c a &
5 0 b: 0 5 1 f h l g f h m h s g c y c a &



Fig 1 a



Fig 1 b



Fig 1 c

operations the upper and lower jaws remained bound together by scars throughout the substance of the cheek that extended from the anterior border of the ramus to the cuspid region. In this patient the restoration of the cheek was made before serious changes in the shape of the bone had occurred and therefore no bone operation was necessary to restore movement.

Paradoxical movement. In Figure 13a we show a diagrammatic representation of the normal jaws indicating the axis of motion in the simple opening and closing. G glenoid fossa and $I E$ the articular eminence which together indirectly form a bearing or guide for the condyle during this movement. T approximately the direction of pull of the temporal muscle in closing the jaw. $I F M$ approximately the direction of pull of the internal pterygoid and masseter muscles in closing jaw. $L F$ approximately the direction of pull of the external pterygoid in opening the jaw. $M H D$ and $H G$ approximately the direction of pull of the mylohyoid digastric and geniohyoid muscles in opening jaw. If $G I E$ is a bearing then the Δ on the condyle would represent the fulcrum the arrow $M I F$ approximately the power and the teeth the load of a lever of the third class. This is approximately true in ordinary movements of the normal jaw. If a bearing for the condyle at $G A L$ were essential to this motion then on removal of the condyle the molar teeth being present the mandible would be converted into a lever of the first class with the load anterior to the fulcrum (Δ) and the power $M I F$ behind the fulcrum contraction of the muscles of mastication would then draw downward that part of the jaw that is in front of this new fulcrum. In this condition Δ the axis of movement and Δ the fulcrum

correspond. On these theoretical grounds we long hesitated to remove both condyles in a double ankylosis until the analysis of reported cases showed that it was not always followed by open bite. It is something of this fear that probably causes men to limit the operation to those cases in which the joint can be reconstructed—an operation less apt to be successful than is a free removal of bone and also it is an operation with a very much more limited field of accomplishment. Our own subsequent experience has shown that these theoretical fears are not entirely groundless. If both condyles are removed at one operation and the upper and lower teeth are not fixed together contraction of the masticatory muscles will cause an opening between the incisor teeth and permanent open bite may result. We have had this happen in 2 cases when the



Fig 1 d



Fig 1 e



Fig 8a

Fig 8b

dental fixation was removed at the end of 3 weeks. In 1 child however in which the condyles were removed at 18 months (Fig 14) due to lack of teeth no fixation of any kind was used and no paradoxical movement resulted. In other cases in which dental fixation was retained sufficiently long 8 to 12 weeks a muscular balance was established that can closely simulate normal movement even when the contact is no bony contact between the mandible and skull behind the occluding teeth the axis of motion remaining approximately normal.

Muscular balance. In Figures 14a and b we have X-ray pictures of the ramus and joint regions of a child who 5 years previously at 18 months of age lost both condyles from infection following bilateral fracture at the junction of the necks with the ramus.

Figure 14c is an outline drawing of an average 18 months mandible showing the lack of development of the ramus at this age and also the approximate line of the fracture in this case.

In Figures 14a and b roentgenograms taken 5 years later it will be seen that following the loss of the condyles there has been little or no subsequent development of the ramus and though the coronoid process have become abnormally long so that the tips approximate the normal point of insertion of the temporal muscles these long coronoid processes have failed to migrate backward to a normal extent as proved by the shortness of the body and also by the fact that the twelfth year molar is seen developing in the base of each.

In this child the body of the lower jaw is in a somewhat posterior position but she can open and close mouth jaw to either side and chew her food satisfactorily but as demonstrated by the X-ray picture she has no bony contact between the mandible and the base of the skull. The chief disability resulting from this condition is that neither this patient nor one other similar one can sleep lying on the back for then the muscles being relaxed the jaw with the tongue drops backward and shuts off the pharyngeal airway.

Second case illustrating a functional disorder without bony contact. Traced profiles of a girl who at 7 years had an auto injury leaving a scar on the chin and was never after able to open her mouth are shown in Figures 15a, b and c. When referred for treatment in August 1915 by Dr A H Hammel



Fig 8c

Fig 8d



Fig 8e

Fig 8f

she then 13 years of age had a complete bilateral bony ankylosis with typical retracted lower jaw as shown in Figure 15a. Both condyles were removed and the dead space was filled with flaps of fat and fascia from the temporal regions. At the same time the body of the jaw was drawn forward until the lower incisors were 4 millimeters in front of the upper and the jaws thus fixed by interdental wire. This gave the immediate profile (Fig 15b). The interdental wiring was retained for 12 weeks and when the fixation was removed she had all natural jaw movements but these movements were not all normal. At a later period Dr L R Main extracted the first lower premolar on each side and drew back the cuspid and incisors into normal occlusion with their opposites. This gave her a rather acceptable facial outline but with later growth the lower jaw failed to retain its harmonious relationship with the upper and at 18 she again had a relatively receding chin as seen in Figure 15c. Five years after the first operation she had an opening of 26 millimeters.

Figures 15d and e show the same girl at the age of 18 years before and after inserting a piece of costal cartilage in front of the mental eminence.

Figures 15f and g are from stereoscopic X-ray films of the right joint region and of the left. W is the mastoid process, G the glenoid fossa, A E the articular eminence, N the rudimentary neck of the amputated condyle, S the sigmoid notch, C the abnormally large coronoid process. Compare the area with corresponding area in Figures 14a and b. It will be observed that a subnormally developed ramus is present in the child who was injured at 7 years while it is entirely absent in the child who lost her condyles at 18 months. Further that while in the younger child at the age of 6 years the twelfth year molar is developing in the base of the coronoid in the girl of 18 years who was injured at 7 and lost

her condyles at 13 the third molar has erupted in front of the ramus (and base of the coronoid)

In the stereoscope it is very easy to verify all of these points. By noting the relation of the ramus and the condylar neck *A* to the glenoid *C* and the eminence *E* it will be seen that the jaw has no bony bearing on the base of the skull and that it has remained in the forward position given to it at the ankylosis operation 5 years previously. The movements are similar to those described under Figures 1*a* and *b*¹

Preangular notch. Retraction of the chin is rather a constant accompaniment of an ankylosis developed during the growing period and is often much more pronounced when the face is viewed in profile than would be indicated from the occlusion of the teeth (Figs 16*a*, *b*, *c*, and *d*). On the other hand facial symmetry is extremely variable.

This 15 year old girl had a fall at 5 years and 6 months later it was noticed that the mouth did not open freely. After the left joint was resected the jaw was swung to the right until the symphysis was brought to the midline. This helped the profile very little and 16 days later a cartilage implant was made into the chin. In making these implants we usually use a piece of the left eighth costal cartilage preserving as much of the perichondrium as possible. Figures 16*a* and *b* show the profiles before the first operation and after the cartilage implant. Figure 16*c* shows the normal joint ramus and angle. There is a characteristic notch at the lower border of the jaw just in front of the angle on the ankylosed side whether it be single or double (Fig 16*d*). In almost all cases of partial single ankylosis the chin deviates toward the ankylosed joint as the limit of excursion is approached. In this case for some unrecognized reason the latter sign was absent and there was no thickening to be felt about the affected joint but in spite of all this and without an X ray examination one could have recognized in this case which was the affected joint by the presence of the notch on that side. This roentgenogram shows the broad contact of the fibrous ankylosis, the shorter ramus and the characteristic notch in front of the angle.

Correction of external deformity. For putting all one has into a case one may be amply repaid (Figs 1*a*, *b*, *c*, and *d*). This young lady referred by Dr A B Kanavel came at the age of 18 with the history of scarlet fever and discharging ears at the age of 4 months and a left mastoid operation at 3 years. Six months later the mouth opening was limited and the chin already deviated to the left. She had had orthodontic work for 10 years and had one fat transplant into chin as evidenced by the scar in Figure 1*a*.

These boys to po th m m t f th m dhl mu
dies h he th bect fl t dy by f mb
d th d h p ed f m t t d q m t m
g and t m d t be nd med by th m m t d y
ramus t f h w Figu 5 b th x p bli t w th
h id ul an th m t ry w th m pl t t t b
t died Th f il eco d f f gu 4 h nly l t ly bec m pl ed

Figures 17*a* and *d* show the characteristic deformities. In order to get clearance for moving that side of the mandible the whole of the left ramus was removed and the jaw was then shifted as far as possible forward and to the right where it was held by interdental wiring. Two months later through an incision made just under the chin the thickest obtainable piece of cartilage was implanted in front of the chin and a long wedge shaped piece slid along the right side of the body the soft tissues at the same time being shifted to the right and sutured in this position.

Figures 17*c* and *e* show the result. Notice the mouth line has been made horizontal the chin is approximately in the midline the left cheek is less prominent and the very deforming flatness on the right side of the lower jaw is almost obliterated.

Figure 1*a* shows the profile before the joint resection and the scar of a previous operation.

Fig 1*b* superimposed tracings made from the negatives showing the condition before the first operation after bringing the bone forward and after the cartilage implantation. Notice in Figure 17*c* how the lower lip and corner of the mouth have been lifted. When she left the city she had an incisor opening of 2.5 centimeters which will still further improve. The space between the lower central incisors was 3 millimeters to the right of the midline above.

Correction of external deformity. Figure 18*a* shows the appearance of a young man who had rickets in infancy but there was no evident causative factor for ankylosis elicited. At 16 years of age he went to an orthodontist and it was found that he could not open his mouth freely. The facial asymmetry became more evident with subsequent growth. When referred to us by Dr C A Thigpen of Montgomery Alabama he was 20 years of age. The chin was well over to the right as shown in Figure 18*a* and there was a free opening between the upper and lower incisors of 1.5 centimeters. The chin was quite receding. An X ray picture showed fibrous ankylosis of the right joint. At operation June 4 1924 most of the right ramus was removed and the jaw dragged forward and the jaws fixed with a pine block between the upper and lower molars on right side with an incisor opening of 3 centimeters. Block and wiring were removed 16 days later and subsequently Dr J H Williams put on an orthodontic appliance with a rubber band that drew the right body farther forward and to the left than it was when the block and wires were removed. Figure 18*b* shows appearance 4 months later. His chin and mouth are still slightly to the right but if a cartilage were implanted the soft tissues would be shifted to the midline as was done in Figure 17 and his profile much improved. Figures 18*c*, *d*, *e*, and *f* show the amount of shifting of the lower jaw that was accomplished by dragging the right side of the body forward at the time of the ankylosis operation.

COLLOID CARCINOMA OF THE STOMACH¹

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BRINTON was the first to make a statistical investigation of gastric carcinoma. He reviewed much valuable data from various sources and published his records about 1857. His analysis of these cases is of considerable value even today.

Much doubt has existed concerning the relative malignancy of colloid carcinoma. It has been designated variously as mucoid, gelatinous and myxomatous and may occur normally in every organ producing or capable of producing mucus. The most common sites of colloid carcinoma are the stomach, large bowel and appendix but occasionally it occurs in the gall bladder, bronchus, breast, ovary, cervix, urinary bladder, kidney and salivary glands.

Certain investigators regard colloid as a consequence of degeneration and others as a secretion but the latest and most accepted view is that it comes from the epithelial cells of the carcinoma. This has been particularly noted both in the primary and metastatic growths. My studies seemingly corroborate this and also seem to show that the colloid originates from the epithelial cells as a secretion and is not a result of degeneration. There are many instances of specimens from carcinomata showing isolated areas of cells with a small amount of colloid formation and many of the cells themselves may be seen to contain colloid, the nucleus being pushed to one side giving a signet ring appearance. Some of the cells may have ruptured showing that the colloid apparently caused too much pressure. The finding of small deposits of colloid in the epithelial cells of carcinoma and in no other cells of the tumor suggests its probable origin from epithelium.

Colloid in carcinoma is said to be a mixture of mucin and other proteins derived from cell degeneration and vascular exudates. Wells says that mucin appears chiefly in two localities in the epithelial cells as a product of secretion and in the interstices of connective tissue especially of tendons. There is also

evidence that mucin or a related body constitutes the cement substance between all body cells. Corresponding to these two chief sources of mucin, mucoid degeneration occurs as a distinct process in mucous membrane or tissues derived therefrom and in connective tissue.

Wells further states that in its typical form mucin is a compound protein consisting of a protein radical and a conjugated sulphuric acid which contains nitrogenous sugar. It is acid in reaction probably because of the presence of sulphuric acid and when boiled with acid yields a substance which reduces Fehling's solution. It is characterized microchemically by staining with basic dyes. It is readily dissolved in weak alkaline solution and is precipitated by acetic acid.

Epithelial mucin represents a distinct product of specialized cells. Mucin formation of catarrhal inflammation is merely an excess of normal secretion and degenerative changes that may be present in the epithelial cell. Even in the extreme example of mucoid change seen in carcinoma derived from mucous membrane for example colloid carcinoma, the epithelial change is not necessarily to be interpreted as a conversion of cell cytoplasm into mucin but is largely due to pressure of secreted mucin on the cells within the confined spaces of the tumor. The mucin is the same as the normal mucin coming from the same source but mixed with larger or smaller quantities of other proteins derived from cell degeneration or from vascular exudates.

From March 1, 1913 to May 1, 1925 there were 2516 pathologically proved cases of carcinoma of the stomach examined at the Mayo Clinic and of these 121 were of the colloid variety, the latter form the basis for the present study.

INCIDENCE

The following data beginning with Branton's first statistical studies and including some of the largest series studied by various



Fig. 1. Network of cells of colloid carcinoma ($\times 150$)



Fig. 2. Area of colloid and a few pigmenting cells ($\times 10$)



Fig. 3. Diffuse infiltration of colloid carcinoma ($\times 10$)

observers give the incidence in relation to the other types of gastric carcinoma as well as to other malignant growths of the gastrointestinal tract. In Branton's series of 135 cases of carcinoma of the stomach 9.4 per cent were of the colloid type. Welch in a review of 121 malignant growths of the gastrointestinal tract noted colloid carcinoma in 2.5 per cent and von Klein in 395 cases noted the colloid variety in 5 per cent. Parham in a review of 784 cases of gastric carcinoma found them in 6.5 per cent. In my series of 516 cases of gastric carcinoma colloid changes were found in 5.09 per cent. In all of my cases the tissue examined microscopically was obtained at operation or at biopsy; thus all cases were verified pathologically.

SYMPTOMS

There was nothing in the histories that could be used to differentiate with any degree of accuracy the colloid carcinomata from other types of gastric carcinoma. Exploratory operation and microscopic examination of tissue offer the only sure method of differentiation. The average length of time (preoperative) that patients in this group complained of symptoms was $8\frac{1}{2}$ months.

SEX AND AGE

There were 25 women and 96 men in the series. The average age of the women was 50.5 years; of the men 53.3 years; the general

average was 57 years. The oldest patient was 79 and the youngest 31 years of age.

PATHOLOGY

The structure of colloid carcinoma of the stomach is similar to that of ordinary adenocarcinoma except that a great deal of thin mucus is present. Many of the lesions especially the larger ones when first viewed at operation are readily recognized because the colloid material is frequently subserous. If the serosa is involved the surface over the lesion presents the small clear tapioca like masses which are typical of this variety of carcinoma. The stroma is translucent and gelatinous either colorless or light brown. The lumen of the stomach often presents a large flat ulceration and in the smaller ulcerations where colloid is not so prominent the craters are frequently deeper. Here is seen a distinct alveolar grayish framework which encloses the colloid granules. In the typical cases all of the wall of the stomach from mucosa to serosa is almost completely changed by the presence of colloid material so that the cut surface is clear and gelatinous and of a soft friable more or less mushy consistency. In these cases practically all of the involved area of the stomach is replaced by colloid which frequently produces a somewhat honeycomb effect.

There were no complete perforations in the series of cases studied. Instead the whole wall



FIG 4. Illustration of colloid material with few gastric cells (\times).

of the stomach was usually thickened as in the scirrhus type of carcinoma. Even in the smaller deeper ulcerations the danger from perforation seemed negligible. When the craters were deep and the gastric wall therefore somewhat thinner the adhesions and thickening immediately surrounding made danger from perforation improbable. There seemed to be a constant regenerative process about the areas of ulceration and destruction.

Most of the lesions were situated at or near the pyloric end of the stomach but many of them were so large that the ulceration extended past the middle of the stomach. In many of the typical cases the line of demarca-

tion of colloid and normal appearing tissue is very abrupt. Grossly the colloid appears to have destroyed the normal tissue or substituted tissue in its place. Often the muscle of normal consistency up to the edge of the cancer then it appears to be completely changed to the colloid type.

The stomachs showing colloid on the serosa were for the most part those containing the larger lesions. In some cases the colloid was plainly visible when the stomach was opened or was presented grossly on the mucous surface when there was no indication of its presence on the serous surface.

Colloid changes may be noted in the earliest stages of the carcinomatous process and are frequently found on microscopic examination when not visible grossly. This is true particularly of the smaller ulcerations when there is a question of simple benign ulcer or carcinoma. The association of ulcer and cancer is so frequent that the possibility of malignancy should always be considered with any ulceration of the stomach. MacCarty (6) believes that most chronic gastric ulcers with a diameter of 5 centimeters are cancerous. Grossly the colloid ulcerations vary from 1 to 14 centimeters in diameter. Some are rather small lesions that appear as simple benign gastric ulcers and their true nature can be detected only by microscopic examination. There are no instances in this series of cases in which



FIG 5. Large ulcer crater. Wall of the stomach nearly destroyed by colloid material.



FIG 6. Depicts the large amount of colloid material.

cancer existed without some evidence of its presence in the mucosa

At operation many cases showed general carcinomatous metastasis taking place as in other types of gastric carcinoma but in addition colloid globules were often found. In many instances the omentum was so extensively affected as to be thickened and board like.

On microscopic examination typical colloid carcinoma presents a fine connective tissue alveolar framework containing a transparent mucocolloid mass. There may not be cellular elements but usually a number of cells or cell fragments are found. In many specimens the cells themselves are filled with the colloid material the nucleus being pushed to one side giving a signet ring appearance. Frequently many cells are seen in a swollen condition and containing hyaline granules.

In certain cases colloid is found only after diligent search and then in small amounts in isolated areas. Some of the more typical colloid carcinomata present a honey comb appearance the larger part of the tissue being completely replaced by colloid material. Colloid appears to stream out from the mucosa to the serosa carrying everything before it. It may be so much in prominence that practically no cells are contained in the meshwork enclosing it. Some areas show meshwork broken as if from the pressure of the colloid within pushing its way between other structures and causing more destruction.

In some specimens the colloid is found in isolated areas with many signet ring types of cells whereas a little farther away the signet ring variety disappears and the typical adenocarcinoma type prevails without evidence of colloid formation. These malignant cells entirely without colloid production may account for the reported instances of metastatic recurrence in which colloid could not be demonstrated. These cells are the most malignant and therefore might have a greater tendency to metastasize. Another possible explanation for the areas of metastasis in which there is no colloid may be found in the results of the experiments of Lim and Crile.

Lim in his studies on animals found evidence to show that the gastric glands are in

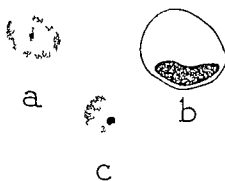


FIG. 7. Normal regenerative cell *a* signet ring type of cell frequently present in colloid cancer *b* malignant cell *c*

the first instance formed of non mucoid cells. Later these cells become mucoid throughout the stomach. The next type to differentiate is the oxyntic and at a later stage the peptic. Peptic cells are present in the stomach of the human fetus at birth. Obviously pepsin is not secreted by the mucoid cell.

Cade found that oxyntic cells disappear and peptic cells lose their granules in the vicinity of gastro enterostomy openings and all the cells appear to be mucoid in character. He inferred from this that the altered conditions had caused the specialized cells to revert to the more primitive mucoid cells.

From the foregoing one might also infer that possibly some of the instances of metastasis in which colloid could not be demonstrated might mean a reversion to the primitive or non mucoid cell.

TREATMENT

Brinton in 1857 said: Of the treatment we will speak little because there isn't any of any value. The first step toward any plan of treatment was made by Fern a Frenchman in 1879 who removed the pylorus and the patient died. The first successful pylorotomy was performed by Billroth in 1881 and from this success came the first hope with regard to the treatment of carcinoma of the stomach.

In competent hands the operation of partial gastrectomy for carcinoma can be accomplished with a mortality rate of less than 10 per cent. In cases in which there is no operative interference the mortality rate so far as we know is 100 per cent. Operation affords the only chance and in the proper surroundings should be undertaken. The earlier the

growth is seen the better is the chance of a cure

OPERABILITY

After the general condition of the patient has been considered and the proper pre-operative measures carried out in order that an operative procedure may be undertaken with the least possible risk the vital question arises. Can all of the growth be removed? A thorough knowledge of the usual metastatic routes of gastric carcinoma is most essential before any type of treatment is instituted. If there is no external evidence of extension of the process especially the evidence most frequently recognized clinically such as supraclavicular lymph nodes of the left side umbilicus rectal shelf and chest and metastatic areas are not detected on palpation of the other viscera a thorough exploration of the abdomen must be made after the stomach has been exposed and the diagnosis verified. The viscera especially the liver peritoneum and pelvic organs should be carefully examined for nodules and then a most sedulous investigation made for lymphatic involvement along the usual routes of lymphatic drainage from the stomach.

Moynihan gives an excellent account of the lymphatic drainage from the stomach the usual sites being classified as primary and secondary. Primary represents the lymph nodes immediately around the stomach for example the lower and upper coronary the right paracardinal suprapyloric right supra-pancreatic gastro epiploic upper and lower and the retropyloric when present. Secondary represents the lymph nodes more remote from the stomach if these are involved the condition may be regarded as inoperable.

Primary lymphatic involvement is the most important to the surgeon because these lymph nodes receive vessels directly from the stomach and should be removed with the growth. Lymphatic invasion occurs early in gastric carcinoma and usually along the lesser curvature. The most important of the secondary lymph nodes are those around the celiac axis because they are the recipient of afferent vessels from all the groups previously described. They are few in number large in size

and lie in the fork formed by the coronary and splenic arteries as they arise from the celiac axis. Some of them pass behind the pancreas to the lymph nodes lying at the root of the mesentery and if involved are readily palpable.

In a case in which the lymphatics appear to be more involved than usual but in which the case is otherwise operable a microscopic examination of the nodes is often of service because they are frequently found to be inflammatory hence what would appear to be an inoperable condition is sometimes found to be quite the opposite. The early and wide extension into the submucosa is clearly seen in sections of the margin of the growth and for this reason the excision should be wide of the margin never under 3 centimeters.

In this series of 121 cases of colloid carcinoma 97 (80 per cent) were found to be operable and the growth was removed. Nineteen were inoperable and 5 were suitable for palliative measures.

PROGNOSIS AND RESULTS

The postoperative course was studied so far as possible and the results in the colloid varieties of carcinoma compared with those of other varieties. According to MacCarty data from which a prognosis may be made are largely compiled from statistics based on the average length of life from the time the physician or surgeon sees the patient. At best it is based on impressions and certain personal opinions since there are so many variables and unknown factors in the problem. In general one considers size of growth cellular character of growth age of the host duration of the lesion relation of growth to nutrition emaciation in relation to food intake proximity of growth to vital structures lymphatic involvement (regional and distant) distant organic metastasis multiplicity of the lesions character of previous treatment and the morale of the patient. The influence of these factors is purely relative and general.

MacCarty (8) further states that microscopically there are four important factors bearing on the prognosis: lymphocytic infiltration fibrosis hyalinization and cellular differentiation. He found in an analysis of

200 cases that lymphatic involvement decreases the chances of postoperative longevity. The younger the host the shorter the life expectancy after gastric resections regardless of lymphatic involvement. Differentiation increases the chances of postoperative longevity. In cases of gastric carcinoma without lymphatic involvement or extensive lymphatic infiltration the greatest average length of postoperative life occurs. Differentiation and lymphatic infiltration combined greatly increases the average postoperative life expectancy. The size of the regional lymph nodes bore no apparent relation to the size of the primary lesion in the stomach.

All of the specimens from the colloid carcinomata were studied grossly as well as microscopically and anything that might have a bearing on the prognosis was carefully checked against the clinical course (Figs. 1 to 4).

The immediate postoperative mortality was about the same as in other types of gastric carcinoma. It was found that in cases in which there was lymphatic involvement postoperative life was shorter.

Specimens showing colloid on the serosa were compared to those in which there was none and it was found that the colloid regardless of lymphatic involvement had increased postoperative life expectancy. Colloid material is apparently a sign of partial differentiation. It appears to destroy the cell or to have that tendency thus lowering the chances of its being so large a factor in recurrence.

The size and depth of the lesion does not appear to be of prognostic import. The presence of the signet ring type of cell did not seem to influence results. According to Parham its presence in the cecum usually means shorter postoperative life.

The prognosis in cases of young patients showing colloid changes was not good. It was much better in those in which no such changes were noted. As a rule the younger the patient the shorter the life expectancy following operation.

The percentage of patients whose postoperative life was 3 and 5 years averaged about the same as in the other types of gastric carcinoma but the chance of living longer

than 5 years was found to be less in cases in which specimens showed colloid changes. From this it appears that the colloid type of carcinoma although it may grow more slowly is more prone to late recurrence. There is not the tendency to fibrous tissue encapsulation in this type of tumor as is often found in other types.

A noticeable and almost constant feature in this series was the manner in which the patients responded to different types of treatment. Those who were operated on and later died improved markedly until recurrent symptoms appeared after this the end came rapidly. Patients on whom palliative resection was performed had a similar postoperative course in most instances. Most of them who were sent home because of inoperable growths did not experience the symptom free period.

According to Balfour an important phase of the indications for resection is seen in the increasing frequency of the palliative resection which has a great advantage over gastroenterostomy in that the growth is removed obstruction is permanently relieved and the patient is assured of several months of comfortable existence.

The present combination of earlier diagnosis and better pre operative and postoperative management is making for higher operability rate, lessened immediate postoperative mortality and better remote results.

The years covered in this study were divided into two periods of approximately 6 years each and the results of treatment in the first 3 years of each period compared. It was found that the number of patients with colloid carcinoma living 3 years or more was definitely increased and the number with other types of carcinoma markedly increased during the latter 6 year period. A study was made of the first and second periods in order to learn if there is a tendency for the lesions to be smaller as methods of diagnosis improve and patients perhaps are coming to physicians earlier. The results were convincing that during the last 6 years of the series the average size of the lesions was definitely smaller.

There is every reason to believe that cases of gastric carcinoma in which operation was

performed in the latter years in the series and those in which operation will be performed in the future will show results superior to the foregoing when enough time has elapsed for a comparison to be made

SUMMARY

1 Colloid carcinoma occurred in about 5 per cent of gastric carcinomata. The percentage of patients living 3 and 5 years after operation is about the same as in these non colloid types of carcinoma. The incidence of late recurrence is greater in the colloid variety.

If there is involvement of the lymph nodes as a rule postoperative life expectancy is decreased.

3 Colloid on the serosa appears to increase the chances of postoperative longevity.

4 There is little tendency to fibrous tissue encapsulation in colloid carcinoma.

5 The postoperative mortality rate is about the same as in non colloid types of carcinoma. Postoperative life expectancy is less in young patients.

6 Colloid changes may be noted in the earliest stages of the carcinomatous process.

7 Exploratory operation and microscopic examination is the only sure way to make a definite diagnosis.

8 Pesection of the growth usually gives a long symptom free period.

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SOME EXPERIENCES AND REFLECTIONS ON ONE THOUSAND
LAPAROTOMIES FOR MYOMA OF THE UTERUS¹BY FLIS ESSEN MÖLLER LUND SWEDEN
P l fOb t t d Cynec l gy t th U ty fL d

THE history of the operations for fibroids is not yet one hundred years old in fact if the early tottering attempts were omitted and only the methodically and carefully prepared and executed operations were considered scarcely a generation has elapsed since the first operation. But what has not been accomplished during this time! As recently as 187 Gaillard Thomas called the operation for myoma 'truly a formidable one' today it is performed at every hospital with the same confidence and the same prospect of a favorable result as is any other abdominal operation.

Many pages have been written by Americans on the subject. Washington Atlee had the great satisfaction of seeing the first successful result after operation for myoma. Kimball of Lowell performed the first operation on a correct diagnosis. I should also mention the names of Emmet, Stimson and Kelly. We are right in saying of them as well as of all other pioneers who have preceded us. In what position would we be if they had not existed?

It is not my desire at this time to state that the technique of operation has been perfected nor do I wish to infer that my figures or my results should be regarded as especially noteworthy. I know very well that others have at their disposal more material and have secured just as good or better results. I would call attention however to that which still remains to be done. The advantages of the different methods of operation are not yet definitely settled. The primary results as well as the secondary might be further improved and radiology prompts us to reconsider the indications for operation. I also believe that a large number of cases from a given source offers better information for the discussion of certain points than would a series of cases collected from many different sources which would mean that different indications for operation are accepted and different tech-

niques followed. The amount of material is becoming so large that we hope eventually the factor of chance will be insignificant and that certain definite conclusions will be reached. Time permits me to touch upon only a few principal questions.

In one thousand of two thousand twelve cases of myomata observed during a given period operation was done that is in about 48 per cent. As is well known the percentage operated upon varies considerably with different gynecologists. Olshausen for example operated upon 16.1 per cent of his cases. Hofmeier 60.7 per cent and Engstrom about 100 per cent. This difference in percentages is based upon the fact that some operators regard the tumors and the operation as dangerous while others do not. Engstrom believed that enucleation was the fundamentally correct method of operation and that it was therefore advantageous to operate as early as possible.

But even with one operator the percentage of cases operated upon may vary. I find proofs of this in my own experience to begin with operation was done in 5 per cent of the cases the percentage then dropped to 38.7. This was at the time radiological treatment was beginning to be used. The percentage again became higher and during the past few years it has reached the point of 63.9. As I mentioned previously the total percentage is therefore 48.1 per cent. operation is considered indicated in about half of the cases of myoma. Until the value of the X-ray in the treatment of myoma is definitely established it will be impossible to say whether this figure is exact and even then there will always be differences of opinion among different surgeons.

The indications for operation are clearly shown in table I. In this table as well as in all the subsequent ones the absolute numbers can be made to indicate the percentages also if in each instance a decimal point is placed in front of the last figure.

TABLE I—INDICATIONS FOR OPERATION

Hæmorrh	494
P	59
Growth	19
Malignant	8
Size of tumor	16
Growing fast	
Painful	
Cystic degeneration	6
Tumor	4
Spontaneous degeneration	6
Small malignant	4
Faulty data	3
	000

It should be stated in regard to Table I that these figures are not the same as those which would be obtained if compiled from examination of the tumors after removal for example examination of slides showed that cystic degeneration was present three times oftener than was suspected before operation.

I will now take up the methods of operation which have been used (Table II)

TABLE II—METHODS OF OPERATION

Simple amputation	799
Total extirpation	
Fetal	49
Extirpation of pedicle and mass	35
	000

I will not discuss the last group as the method of operation is familiar to all. However the relative value of the other groups is by no means as yet determined. That from a technical point of view supravaginal amputation is more easily performed than is total extirpation can hardly be disputed. Besides being more easily performed it can also be done more quickly which means that not only is it not necessary to keep the patient anesthetized so long and to use so large an amount of anæsthetic but of still greater importance the tissues in the pelvis are injured less.

Is this reasoning correct a difference in the results can be expected. The adherents to the principle of total extirpation look upon such a difference as unimportant and lay stress upon the fact that the results after total extirpation are improved each year so that the two methods are now on an equal footing.

Doederlein gives a death rate of 5 per cent as an average for total extirpation and emphasizes

the fact that this is a great improvement over the early death rate of about 9 per cent. This opinion may also be accepted but it seems to me to be just as indisputable that the death rate after supravaginal amputation is less in later years. My experience points in the same direction. The death rate after supravaginal amputation in my series of 799 cases is 2 per cent after total extirpation in 117 cases 6.9 per cent. It should also be remembered that total extirpation has been resorted to in more serious cases such as for tumors of the cervix and malignant tumors and the results therefore are not quite comparable with those for supravaginal amputation. If total extirpation had been used in the cases in which supravaginal amputation is now done it might be that there would be more similarity in results. At the present time however I cannot help but feel that the immediate safety of the patient is greater after supravaginal amputation than after total extirpation.

The question however is not completely answered by the primary results for we must consider the patient's subsequent state of health. An examination of my cases gives the following information. Of 74 patients upon whom total extirpation had been done 69—93.2 per cent—were in good health while 5—6.8 per cent—had some trouble. Of 486 patients upon whom supravaginal amputation had been done there were 91.3 per cent without trouble and 8.7 per cent with trouble of some kind. The difference is slight and can be explained by the fact that exudation and hæmatomata which are sometimes observed after supravaginal amputation do not arise very easily after total extirpation which provides better drainage. This advantage however is counterbalanced by a certain unpleasant dryness in the vagina and introitus which does not appear after supravaginal amputation after which the discharge of mucus from the cervix is kept up. The figures I have quoted do not seem clearly to lend favor either to one or the other method.

In the presence of both a malignant tumor and a myoma it is evident that total extirpation is the operation of choice. Herbert Spencer is an energetic champion of total

extirpation as a standard operation in such cases. He reports his own cases as well as those of others in which the presence of the two conditions was overlooked or discovered too late.

It seems to me that this very question with which future research workers have to deal is at once the most important and the most problematic to solve. I do not enter here upon the question as to whether the myoma itself degenerates and becomes malignant or whether the two forms of tumor develop simultaneously with or without any etiological connection. The questions I would emphasize are: How often does the condition occur and is it possible to diagnose the presence of the two conditions before operation?

Since 1905 all myomata removed at operation have been examined histologically at the pathological institution through the courtesy of my colleagues Forssman and Sjövall. It is true that it has not been possible to make examinations systematically in the sense that all large tumors have been studied in serial section, but we have endeavored to examine especially carefully those which appeared suspicious to the trained pathological eye. If a few cases have escaped attention the final figures may be a little lower than they would have been if all cases had been examined. A tabulation of the findings from the examination of the myomata removed during a period of 20 years at one and the same place is shown in Table III. Curiously enough our figures coincide with those of Kelly, who in one thousand operations for myoma found both myoma and cancer twenty-eight times. In the cases enumerated in Table III a diagnosis of malignant tumor has been histologically confirmed by competent pathologists. Cases in which a tumor was suspected on clinical examination but in which diagnosis was not microscopically confirmed are not included.

It should be added that at operation for some other condition and at postmortem examination myoma as well as malignant tumor was found in 21 cases: 1 with sarcoma, 1 with adenosarcoma, 14 with cancer of the uterus, 4 with cancer of the ovary, and 1 with cancer of the vagina. As these cases do not belong

TABLE III—CASES OPERATED UPON DURING TWENTY YEARS

Myoma plus sarcoma	C	18
Myoma plus cancer of cervix		
Myoma plus cancer of uterus		5
		23
To these may be added		
Myoma plus cancer of tubes		1
Myoma plus cancer of ovaries		3
Total		27

to the one thousand in which operation has been done I wish only to mention them. My material should therefore indicate a frequency of 3 per cent for the significant complication. The figures from other places vary between no per cent (Pfannenstiel) and 10 per cent (Warnekros). This probably is not dependent upon mere chance but on the difficulty of discovering the presence for example of a sarcoma or a highly cellular myoma. However this may be the combination appears in a certain number of cases and thus the question arises: Is it possible for us to diagnose the condition before operation?

I regret to say that for my own part I must give a reserved answer. Just as simple as the diagnosis may be in some cases just so impossible does it seem in others. Curettement which might otherwise reveal the secret meets technical and other difficulties in a uterine cavity which has become distorted by the myoma. Should this difficulty not be present and it were possible thoroughly to curette the cavity not much relief is obtained as regards the sarcoma of the uterine wall.

The difficulties mentioned with regard to the diagnosis are further illustrated by the fact that in 19 of 29 cases the malignancy was not even suspected far less diagnosed. In one of the cases in doing a supravaginal amputation the operator cut across a sarcoma which had infiltrated the cervix. I wish to emphasize again the great task which still remains to be solved through the study of the myoma problem.

It seems obvious to me that the choice between supravaginal amputation and total extirpation is dependent upon factors which cannot yet be definitely decided. Not until we have learned to diagnose before operation the simultaneous presence of a malignant

tumor and a myoma can we without hesitation do total extirpation as the treatment of choice in these cases. Possibly the use of supravaginal amputation in the future might be limited to the advantage of total extirpation. It may be added that I have not once observed carcinoma in the portio vaginalis after supravaginal amputation.

The conclusion I have reached with regard to the choice of method in operating is this: If in a patient before during or after the menopause a uterine tumor begins to change to increase in size rapidly to produce more abundant hemorrhage and to be painful and if the patient is losing flesh then malignancy ought to be suspected and total extirpation should be done. As a matter of course the degeneration may be of another kind but even then the tumor ought to be removed and total extirpation is safer.

Much has been written and said about the value of enucleation in the treatment of myoma so I will not repeat here all the arguments for and against it. Suffice to say that besides Martin other eminent gynecologists consider enucleation fundamentally superior. I need mention only the name of Otto Engstrom. In my own experience enucleation has been done 49 times without a fatality. There is thus nothing to be said as to the immediate results. The fundamental reasons for this method of treatment are not focused on immediate results but on the question of a later pregnancy and recurrence: the strength of the operation is to be found in the fact that pregnancy is possible; its weakness is in the risk of recurrence. As to the possibility of pregnancy after enucleation Engstrom states its frequency as 6.5 per cent. Winter on the contrary only 3.2 per cent. In my experience pregnancy followed enucleation in 6 cases that is in about 12 per cent—a figure of importance.

In contrast to this group of patients in whom enucleation has been done and thus the full function of the generative organs preserved is another group that is not fully satisfied namely those who have had a recurrence of hemorrhage or of a tumor. Martin claims that this condition is found in 6 to 7 per cent. Engstrom and Winter in 6 per

TABLE IV—PRIMARY MORTALITY

Pelvic myomectomy	Cases
Infection	13
Pneumonia	4
Endocarditis	
Emphysema	
Edema	
Uterine fistula	
Red tautomy	
Chronic anemia	
Malignant tuberculosis	
Suffocation (aspiration of blood clot in the stomach)	

cent. In my experience the number is higher—18 per cent. Such figures must of course be regarded as proof that the operation has been deficient in some respects and it must be so understood by the patient. Some patients have been obliged to be operated upon again and this was true in not less than 5 of my 9 cases. Add to this the fact that of the patients operated upon radically a considerably larger number 91 to 93 per cent are definitely in good health without any trouble while after enucleation several (in my series of cases about 3 per cent) complain of discomfort such as pain, menstrual disturbance and the like. It cannot be denied that this is often a drawback to an operation which is otherwise ideal in the sense that it removes the diseased part without sacrificing any of the healthy tissue.

In spite of the great respect that I have for the memory of Engstrom having been his pupil and in spite of the admiration I have for his contribution to this matter I do not however consider it possible to imitate him in giving enucleation the place of honor as the principal method. Even without such aspirations it has a place of honor among the operations for the treatment of myoma and cannot be replaced. In the course of time my own viewpoint has become such that I perform enucleation only if the patient is young for instance below 35 years of age and if an approaching marriage or other circumstance renders the preservation of the power of conception specially desirable. I consider it a duty to the patient to explain the situation to her before the operation that she may decide a question that so closely affects her future.

I next arrive at the question which interest all and especially the operator who is respon-

sible for the operation that is the question of primary mortality. In my material the primary mortality has been 2.4 per cent. I am quite aware that many in America are able to show better results. The causes of death are shown in Table IV.

Table IV is self explanatory, so I will mention only the first two items. With regard to embolism the mortality amounts to 1.3 per cent, a figure corresponding to that stated in other series. It would seem unfortunately that the causes of embolism would remain unknown for some length of time and that we would not be able to protect the patient against this danger. I have tried to promote the circulation of the blood and to counteract the want of exercise by means of massage performed by a competent person and started the day after operation. However I dare not yet express an opinion as to its use. As during this time there have been five cases of embolism in a series of 300 operations for myoma. The four cases of infection deserve mention as it would seem that with our up to date aseptic technique an infection ought scarcely to be met with.

An operative infection with a fatal termination has fortunately occurred only once. A real operative infection appeared in one case in which I have not the case history. The patient succumbed to paralytic ileus. In another patient the cause of death was an infection from a postoperative retroperitoneal hematoma. In a third case there was present a gangrenous myoma which resulted in an intraperitoneal abscess which was drained at operation. Autopsy showed septicæmia and also that by means of drainage the spreading of the infection into the peritoneum had been prevented. And finally the fourth case is of interest because the infection had originated from an intra uterine radium treatment later followed by operation with the result mentioned.

It may naturally be asked if any of these deaths might not have been avoided. As far as the cases with pulmonary embolism are concerned such an expectation is unfortunately not yet justified. As regards infection an operative infection may be so far avoided that it cannot exercise any great influence on

the result. On the contrary it is not possible to avoid an infection that arises from a tumor already infected or gangrenous and operation has to be done as a last resort. It must also be remembered that a university clinic in Sweden must receive cases which have been turned away from other clinics. Should we in such cases consider our statistics first or should we bear in mind the welfare of our patient?

As to the other causes of death, two at least could have been avoided: the injury to the bladder which occurred in one of the earlier cases and the aspiration of vomitus. In the latter instance the patient vomited while alone and aspirated the contents. It should also be acknowledged that however careful we are or consider ourselves to be and however much the results are being improved with age and experience, the day will surely never come when the results in a series of operations becomes such that improvement could not be made. To balance the risks correctly before interference is skill, to say the least. *Es irrt der Mensch so lang er strebt.*

In a number of cases there have been other complications of consequence and yet the outcome has been favorable. We would mention thrombosis in 9 cases, pulmonary embolism in 4, parametritis or possible hematoma in 5, and pyelitis in 2, as well as lesions in the ureters in 1. I will not dwell on these.

Other complications such as concurrent adnexal disease which have been diagnosed before operation are of great importance. Their nature is shown in Table V.

TABLE V

	Cases
Ovarian or para-ovarian tumor	4
Malignant ovarian tumor	3
Hydrosalpinx	3
Pyosalpinx	8
Tuberculous	10
Extra-uterine gravidity	2
Tubal cancer	1
	<hr/> 69

The interesting point as far as treatment is concerned is that in more than 39 cases the complication was not diagnosed before operation and in most of these cases perhaps

30 there were certainly ovarian tumors present which were not discovered until operation. This has no other influence on the operation than that the adnexa are also removed. But the lack of knowledge as to the presence of adnexal disease may influence the decision of the surgeon as to the method of treatment to use—whether operation or the X ray.

Among other peculiarities in the cases of myoma operated upon I will mention only that in the last series of 300 cases of myoma myoma of the cervix appeared 7 times, a retroperitoneal myoma 9 times and a degenerated cyst 10 times.

I will not enter at this time into the question of pregnancy in the presence of a myoma as these cases in many respects and especially from an obstetrical point of view should be treated separately. I take the liberty only of contradicting the opinion that seems to prevail in certain publications in recent years that a myoma present in a pregnant woman should be removed for the reason that the growth may possibly give rise to complications during parturition. The morrow bringeth counsel. A myoma without any symptoms neither need nor should be operated upon during pregnancy.

There is still another matter of importance which I wish to mention. What will the result be if in removing a myoma both the ovaries are removed or one or both are left?

The question has been much debated and has had many different answers. It surely does not seem just to remove the ovaries unnecessarily in a young woman who is many years from the natural menopause. Again in another who has reached this period or is near it the risks seem less if the removal of the glands from technical or other reasons be advantageous. What are the real facts in the case?

I regret that I did not earlier pay the attention to this question that it no doubt deserves. I am not able therefore to make an exact statement except in reference to the last 300 cases. Of these 300 cases in 77 both ovaries were removed and I have definite information regarding them. It is remarkable to note that in 64 of these cases 84.4 per cent there was no trouble and 4 patients were less than

40 years of age. The 13 patients who had trouble that might be connected with the castration were all between 40 and 52 years of age. On the other hand I have reports on 64 patients operated upon in whom one or both ovaries had been left and in whom there was no reason to expect endocrine disturbances. Of these 9—14 per cent—had symptoms of menopause. The ages in this group ranged from 31 to 43 years.

From these experiences it seems to me that two facts might be mentioned. First it is not easy to judge whether the symptoms really depend upon something else—a neurosis—a suggestion or whatever it may be—to which the operation has given rise or whether they might be the result of the removal of the uterus for why should such symptoms be observed in patients whose ovaries have been left? Second in a large number of patients the ovaries have been removed and no such symptoms have appeared and many times the patients are less than 40 years of age. I have therefore in the course of time come to the conclusion that the ovaries are not to be removed even in patients more than 40 years of age if menstruation still persists at the time of operation. On the other hand there need be no scruples again the removal of the ovaries if the adnexa show such change that the chances of the patient would be improved by ovariectomy.

I have touched in this paper only lightly upon a question which is still of such grave importance that it deserves thorough study. That is the question of the relative indications for treatment by operation and by X ray. The reason for this is that I have not yet had sufficient experience in this direction. I believe that one ought to wait until he has a large series of cases in which the X rays have been used and that such patients should be watched for many years before a definite statement is made as to which method of treatment is indicated—operative or radiological—in a given case. I shall restrict myself to the statement that I have tried the intra uterine application of radium to myoma in 101 cases but I have abandoned its use entirely. In the cases so treated a diminution in the size of the tumor was noted in 60

cases a favorable influence on hemorrhage in 87 cases but in 15 cases infection set in. For some reason or other 12 patients had to be operated upon later and 3 patients who were free from cancer before treatment were found to have it later. In late years I have cautiously and feelingly used the X ray treatment but the number is only 51 so far. The result of such treatment has been that immediately or after renewed treatment hemorrhage has ceased in 70—6 per cent—and that in 98 per cent operation has later had to be done. We should bear in mind in this connection the possibility of malignancy or other

degeneration being overlooked through faulty diagnosis.

Time will show to what extent X ray treatment is adapted to give the patient the same security as the operative treatment without subjecting her to the added risks. Should this be possible X ray treatment without any hesitation may replace the operative treatment should it not be possible I believe that an operation which removes the diseased part and leave the healthy is more to be desired than a method of treatment which by way of the ovaries influences the production of hemorrhages but leave the tumor.

SUPPURATIVE DISEASES OF THE CHEST

BY CIOPIGI P. MULLER, M.D., ILL. S. PHILADELPHIA

SUPPURATION within the chest would seem to be a comparatively simple matter to discuss and yet the uncertainty regarding certain phases and the technical difficulties involved in many of the procedures make it complex. As I have no new methods to offer and the recent literature is so full of productive work, I am forced to present to you the opinions of one who does general surgery with perhaps more than the average experience in chest surgery. Speaking as one surgeon to another we can exchange ideas regarding our own methods taken as they usually are from the more highly specialized studies of those engaged in a particular problem.

The great groups are empyema, lung abscess, bronchiectasis and mediastinitis. We must omit any preliminary discussion regarding the anatomy or the physiology of respiration, however tempting the latter may seem. Every surgeon who undertakes chest surgery should be familiar with the studies of Graham and the earlier writings of Garre, Sauerbruch, Willy Meyer, Lilienthal, Hedblom, to mention only a few which stand foremost in my mind. The section on pulmonary suppuration in the monograph of Garre and Quincke published in 1911 can be the starting point and upon this

base little by little one can build a knowledge of the shifts and changes which have had to occur before chest surgery attained its present sound position.

Empyema is the most important suppuration in the chest in the experience of most surgeons. As seen in ordinary civil practice it is practically always the result of a pneumonia. At this time we will not discuss whether it results from lymphatic or contact infection of the small serous effusion present in nearly all cases or whether it is due to the rupture of small abscesses on the periphery of the lung.

There are three matters of paramount importance. The first is to recognize the probability of empyema in every case of pneumonia that it does not get well promptly. Delayed resolution is often another name for empyema. Prompt diagnosis is essential to low mortality and freedom from the chronic cavity. The second point is the need to distinguish between the synpneumonic and metapneumonic effusion. Operation should be delayed if possible until the pneumonia has resolved. There are statistics showing that the mortality approaches 50 per cent in a group of cases operated on during the first week after onset of the pneumonia whereas it was 10 per cent between the fifth and eighth week. The latter

then the work of Cutler and his associates have pretty well established the fact that most lung abscesses after tonsillectomy result from septic emboli just as do those after operations on other parts of the body. Smith however believes that his experiments prove the opposite and that aspiration is the potent factor. We must not exaggerate the frequency of abscess after tonsillectomy because an operator may do thousands of tonsil excisions before he has one abscess of the lung as a complication. Weil (1935) makes the interesting suggestion that when the patient never seems to convalesce has fever, constant cough and chest pain then aspiration may be the cause whereas when normal recovery has occurred and suddenly about 10 days later the chest symptoms develop embolus is the factor.

The diagnosis of lung abscess is not particularly difficult if we pay strict attention to the history and character of the sputum in the case of a patient with cough, fever and chest pain. When suspicious we can get clear cut evidence from the roentgenograms if these are well taken because the casual roentgenologist rarely gets good pictures of the chest. Needle biopsy should never be used as a diagnostic aid because of the danger of producing pyothorax. The obscure cases are those small collections about the hilus and the interlobar collections which may be called loculated empyemata by some or abscess by others. If an expert bronchoscopist is available an additional aid to diagnosis is furnished. Nor need we be concerned as to the existence of abscess or gangrene. Most of the abscesses multilocular as they are have areas of gangrene in the walls and the massive gangrenes result from large infarction with death of the lung parenchyma before cavitation occurs. The symptoms of massive gangrene are so acute that there is hardly time for treatment before death occurs. Bronchiectasis is associated with most chronic abscesses but only becomes an entity when widespread throughout one or both lungs.

The treatment of lung abscess requires perfect localization, a nicety of judgment and careful technique. The internist, roentgenologist, surgeon and if possible the bronchoscopist should work together for the best

interest of the patient. The roentgenologist determines by the plain film and after lipiodol injections the exact location of the cavity whether or not it drains and the extent of bronchiectasis. The bronchoscopist inspects the bronchial tree particularly for foreign body or tumor, notes the condition of the mucosa and whether pus is flowing from the lobes. He injects the lipiodol to outline the cavities and to diagnose the bronchiectasis; he also decides particularly in the case of lower lobe and hilus collections as to whether or not he can improve or possibly cure the patient by frequent bronchoscopic aspirations. The internist endeavors to improve the general condition of the patient, advises diets of high caloric value, administers arsenamine for the fever or gives creosote, arranges for blood transfusions in the very anemic and tries particularly by postural methods to effect drainage of the cavity.

We are all agreed that the desirable thing for the patient is to have the abscess drain into the bronchus. It is most unwise to operate during the more acute phases of the disease when the area of pneumonitis is extensive and the bronchioles are filled with pus. For both reasons non operative methods always should be given a fair and extended trial but the method should be thorough and persistent. Perhaps 30 per cent will get well and stay well under rest, postural drainage and bronchoscopic aspiration. With Graham (1926) I am somewhat skeptical of the value of bronchoscopic aspiration alone but Jackson and Tucker have had some very interesting cures in our hospital. Such treatment presupposes the probability of drainage and the X ray and bronchoscopic examination determines this point. If drainage is not accomplished if the abscess is well up in the upper lobe or at the periphery then operation should be performed as soon as the patient's general condition has been improved. Sharp localization in the X ray picture shows the subsidence of the pneumonitis. Even if drainage is accomplished, the persistence of the cavity is an indication for operation. Furthermore I am of the opinion that with any degree of bronchiectasis external drainage of the cavity is advisable. I do not mean bronchiectasis of the lung but bronchiectasis of the lobe. Do not delay too

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time is probably too long but certainly we should wait until the signs and symptoms indicate that the pus collection predominates and the pneumonitis has cleared.

The third point to be emphasized is the need for discrimination and individualization in the technical aspects. Either an esthetic probably can be safely used in most cases but there is no need for it and certainly it is contraindicated in those who are sick. Local anesthetic is and sometimes a little gas for induction is quite sufficient. Since the day of Hewitt (1876) and again since the War we have had periodic advocacy of drainage through a catheter as a standard method. I have practiced interlobar puncture in 94 per cent of my cases. But the experience of most surgeons is that open drainage is required sooner or later in most cases. In our series it was 77 per cent of the children and 94 per cent of the adults requiring a rib resection after the preliminary intercostal tube drainage.

The point is this: we must not create an open pneumothorax while a pneumonia exists. If by reason of a streptococcal empyema as seen in the camps during the War or if because of great toxemia or peritonitis the pneumonia is so severe that we must operate during the symptomatic phase with its walled off abscess and thick pus a rib resection with adequate drainage is indicated. Let me caution you not to delay too long if there is need for better drainage after a few weeks of intercostal tube drainage. The temperature reactions and the X ray picture furnish the guides. As I am trying to deal with principles only no discussion will be added regarding irrigation complications or after treatment. I am adequate dependent drainage is essential to success all else merely helps a little. Chronic empyema with cavity is an end result usually of delay and inadequate treatment. Before undertaking the serious and difficult operations for its cure we should study the writings of Kellor and Heddington.

Abscess of the lung is a more serious affection than empyema not only from the standpoint of treatment but also because of the greater difficulties in diagnosis. Some discussion of the etiological factors is essential. At least 50 per cent are postoperative in origin and about one half of these follow the operation of tonsillectomy. It is difficult to evaluate the exact mechanism concerned in the nonoperated group. Lord (1925) believes that lobar pneumonia appears to be of little moment in the etiology and in origin in bronchopneumonia. But some of the cases are so clear cut that it is probable that a small but definite group do follow lobar pneumonia. A larger group arises from the bronchopneumonias because of the greater damage to the lung. Most likely the lung in certain patients develops a low local area of resistance and secondary invasion of chance pyogenic organisms or of the various cocci vibrios, streptococci and fusiform bacilli found in tonsillar crypts and around the teeth determines the breaking down of tissue. Smith (1927) has produced abscess by the injection of these organisms into the trachea and has noted that it is probable that abscess goes through a preliminary pneumonic stage before breaking down. I perhaps some of the apparent pneumonia as described by patients with abscesses are examples of this primary pneumonia. Villan (1906) offers some suggestive proof that paranasal sinus infection is capable of reaching the lung by way of the lymphatics. Foreign bodies of vegetable or other origin constitute a second group of suppurative diseases of the lung but this only simulates abscess and is more of a bronchiectasis because removal of the foreign body is almost invariably followed by recovery.

More interesting is the group which follows operations. Septic emboli from any focus discharging into the general circulation may cause acute abscess. When multiple the outlook is bad particularly as the patient is generally septic. Operations on the upper air passages have been a source of controversy now for several years. The great number of tonsil operations performed offers the probable explanation. The field is septic and the parts in continued motion. I believe and Do (1923) brought this fact to our attention and once

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long and do not let your patient get away from treatment until cure is effected.

When operation is finally decided on many interesting technical points open up for discussion. In simple process I have found it best to resect a portion of one or two ribs over the area of abscess without opening the pleura. Some gauze saturated with mercurochrome solution is then packed against the parietal pleura and the skin flap temporarily closed. Four or five days later the wound is reopened and it will be found that the lung is sufficiently adherent in practically every case so that the cavity can be entered with the cautery. The opening should be large and the cavity carefully drained and cleaned with the suction aspirator. If it is small I use only a large soft rubber tube but if large some mercurochrome gauze is lightly packed in for two days. All of these procedures should be done strictly under local anesthetic. Shortly the cavity should be inspected for additional pockets and these and bronchiectatic openings can be opened up or treated with a small cautery point. This is the reason for making the external opening sufficiently large. I always keep the drainage tube in place for many months particularly if there is bronchiectasis otherwise flare up will occur requiring re-opening of the incision. In some cases a limited thoracoplasty may be necessary. I do not believe that phrenic nerve section or crushing is worth while. No mention was made of artificial pneumothorax because I do not think it is a wise procedure. The exposure of the abscess is easy enough if it is perfectly localized except in the case of the upper and middle lobes high up and posterior. But the scapula can be winged by dividing the rhomboid muscle or the lower part of the scapula can be resected. In one female patient I was obliged to work well under the breast to expose a high anterior collection. I have entirely given up the older method of suturing the lung to the parietal pleura.

Bronchiectasis is the third suppurative in the chest. Usually some parenchymal inflammation such as an influenzal bronchopneumonia induces a fibrosis and this twists and obstructs the bronchi causing their dilation. When the dilated bronchi become the seat of a suppurative bronchitis purulent sputum

results which may be slight periodic or continuous and exceedingly offensive. We must always remember the possibility of a vegetal or other foreign body as an etiological factor. In some cases an infarction from mildly septic emboli may produce a suppurative pneumonitis with invasion of the walls of the bronchial tubes and as Singer puts it a sort of carbuncular ulceration occurs. These small pockets then appear to the roentgenologist as bronchiectatic areas. Areas may be masked by shadows of the heart or diaphragm the fibrosis may be confusing or the pleura thick thus making every diagnosis difficult. The injection of lipiodol has made such cases more apparent and has greatly enhanced our ability to diagnose bronchiectasis and determine its extent in a lobe a lung or both lungs.

Surgical treatment of bronchiectasis has not yet attained a perfectly secure basis. It is conceded that the disease must be unilateral. Pneumothorax is not satisfactory. Intrathoracic lobectomy is too hazardous. Graham (1923) has offered a great improvement in his operation of cautery excision. A flap of the chest wall is turned up and 3 or 4 ribs removed for distances of about 4 inches. The exposed ends of the ribs are packed with bone wax to minimize the danger of osteomyelitis and the adjacent intercostal nerves injected with alcohol to destroy sensation in the wound. The pleura is then opened with a small incision and if firm adhesions are not present the cut is closed and the wound packed for a few days. Either at the first or second stage a large soldering iron heated to a red heat is pushed into the lung and the suppurative bronchiectatic area cauterized. It is essential to so cauterize as to obtain multiple drainage openings by exposing a large cross section of the bronchial tree. In about 3 weeks cauterization is repeated. Hemorrhage is controlled by packing and this is efficient because the blood pressure in the pulmonary artery is usually only about 5 to 25 millimeters of mercury. Graham suggests that if ligation of a branch of the pulmonary artery to a lobe in the human being should prove to be as easy and simple an operation as Sauerbruch claims it to be then the danger of hemorrhage could practically be eliminated in the operation of

cautery pneumectomy by first performing a ligation of the corresponding branch of the pulmonary artery. If ligation of the corresponding pulmonary vein should also be performed then the danger of cerebral embolism would also be excluded.

Following the lead of Friedrich Sauerbruch and others Hedblom (1923) has advocated a graded extrapleural thoracoplasty for diffuse unilateral bronchiectasis. The whole lengths of the lower ribs usually from the third to the eleventh inclusive are resected in multiple stages the number of stages depending on the condition of the patient. While the diseased bronchi are not eradicated by the operation it has proved effective to the extent of markedly relieving cough and sputum in all cases approximating a cure in many. This operation is the only hope for patients in whom the disease involves more than one lobe of the lung. When the bronchiectasis involves the lower or perhaps the upper lobe alone it seemed feasible to amputate that lobe but in the hands of the average surgeon this operation has had a mortality approaching 100 per cent. Recently Whittemore (1927) has advocated delivery of the affected lobe outside the pleural cavity with anchorage by suture. In about 10 days the lobe becomes necrotic sloughs off and leaves a clean granulating stump deep in the pleural cavity with a bronchial fistula in it. The operation is similar to that proposed by Lockwood (1922) for abscess.

We must choose between these operations depending on the pathology. In diffuse unilateral bronchiectasis without abscess graded thoracoplasty seems obligatory. In lobar bronchiectasis and this is usually complicated by abscess extrathoracic excision of the lobe may be considered if there are no adhesions. In the presence of adhesions and multiple abscesses the cautery method of Graham seems best. The objections to thoracoplasty as leaving infected bronchial tissue are met by the statement that secondary cautery operation is feasible. Hemorrhage following cauterization is to be feared but usually is controllable with gauze packing. The occurrence of cerebral embolus is not confined to the cautery operation. I have lost two patients

after simple drainage from this cause when recovery from the abscess had practically resulted.

Suppurative mediastinitis is the last of the group under consideration which I will discuss. The sources of mediastinal suppuration may be traced to the adjacent bones the lymph nodes as an extension from the neck especially after operations in the lower part which are followed by suppuration or as part of the suppuration of streptococcal empyema. I have had deaths from this cause after an operation for intrathoracic goiter after esophagotomy and after block dissection of the neck for cancer. The symptoms are grouped under the head of pyrexia and pressure on structures in the mediastinum. When recognized the abscess should be opened and drained. This is easy of performance in the case of the anterior mediastinum but in the case of posterior mediastinitis one must choose between cervical mediastinotomy and the dorsal approach preferably by the method of Heidenhain. The latter certainly gives better drainage but is harder to perform.

Even from this rapid review one can become enthusiastic about thoracic surgery. The problems seem more complicated than those met in the abdomen but this only makes the subject more fascinating. Rather recently a new field is opening by reason of the development of a method of thoracoplasty for the cure of certain cases of pulmonary tuberculosis but the treatment of tumors of the lung still awaits solution. It will not be long before the surgery of the thorax attains the same sound position that is occupied by the surgery of the abdomen and cranial cavity and this will lead to greater refinement in technique lower mortality and better end results.

DISCUSSION

Dr C. A. HEDBLOM, CHICAGO: Dr Muller's presentation seems to me remarkably comprehensive, concise and detailed considering that his theme embraces the major portion of the whole field of thoracic surgery. With most of Dr Muller's postulates I am in entire accord. To one or two of them I should like to add what emphasis I may. To some particulars in which I disagree I shall devote most of the limited time at my disposal.

In his discussion on empyema Dr Muller very properly emphasizes the importance of early diag-

nosil and prompt drainage the avoidance of pulmonary morbidities in the pneumonic stage and the indication in the choice of technical procedure. I should like to stress the value of the so-called closed method of treatment of empyema. It represents the practical application of the operative technique in the procedure of treatment developed by me, the following decade namely the avoidance of the pneumothorax incident to the time-honored rib resection and drainage in any patient with a large capacity from any cause. All respiratory capacity obtains in the presence of a pneumonia in the presence of the hemolytic streptococcus before the lung has become adherent in the infant and the aged irrespective of the lung infection and in the adult stage after the pneumonia with empyema. The avoidance of infected fluid in the thoracic cavity is stage by the closed method followed by the effective solution of irrigation relieves mechanical emphysema to respiration from the fluid in the thoracic cavity and the lung to the normal latent height and so improves respiration less noxious absorption and by the use of the antiseptic fluid the combination of the infection.

The following table explains the following procedure: 1. The closed method properly carried out in the thoracic cavity requires but little than any other method. 2. Properly carried out it will be if the patient is left at home to the care of the family. 3. Entirely unattainable except to the doctor. 4. With hospital care and the trained attendants the closed method is not only safest and most effective but also constitutes the definite treatment of empyema.

In his discussion of pulmonary abscess Dr. Muller touched on several points over a long period. With regard to the etiology of postoperative abscesses, he made the statement that most surgeons consider them embolic in origin. I am under the impression that most surgeons are generally interested in this conclusion to believe most of them to be of the inhalation type. The postoperative abscesses of the embolic type are their content chiefly on their failure to obtain pulmonary abscesses do follow in installation of infected material to the trachea. Other workers among them Smith, Crook and Loomis who have been in the Research and Educational Hospital of the University of Illinois have obtained abscesses in a large number of dogs and other animals by injecting infected material into the trachea. The practical importance of this discussion is that a long time weight of evidence indicates that a large proportion of postoperative abscesses of the pulmonary type and post-

operative abscesses are due to inhalation infection. Every possible precaution against such operative inhalation infection is obligatory.

Lipiodol contrast media roentgenography provides an considerable value in the diagnosis of atypical cases of pulmonary abscess particularly such as produce a shadow difficult to differentiate from a pleuritis. The lipiodol fails to enter the terminal bronchi in the pulmonary portion of the lung surrounding the abscesses. Secondary abscesses imperfectly defined may also be demonstrated by injection of the lipiodol through the bronchus draining into the thoracic cavity. Secondary bronchiectasis may be demonstrated by similar means.

The choice of treatment of pulmonary abscesses depends on the results on three criteria: (1) the clinical picture of the case, (2) the location of the abscess, and (3) the pathological anatomy of the abscess. If the patient is progressing, improvement is expected, treatment and postural drainage is indicated indefinitely. If the symptoms are marked and at a standstill, more active treatment is desirable after at most 8 or 10 weeks. If the progress is steadily downward, active treatment—particularly drainage—may save the patient's life. Some of the very best results in my experience have been early in acute cases of this type. According to my observation the proportion of cases that get well spontaneously is much nearer 50 than 30 per cent. The safest and most logical treatment of a central abscess and perhaps pulmonary abscess is postural drainage and bronchoscopy. The only rational treatment of a large peripheral abscess draining imperfectly through a long tract into a bronchus is thoracotomy drainage.

Chronic abscesses may require cautery treatment to heal bronchial fistulae and the acaplasty to obliterate fistulae. Cautery excision is obligatory for the honeycomb type of abscess. Cases of multiple abscesses involving a whole lung are usually beyond surgical relief.

Lipiodol contrast media roentgenography is the diagnosis of bronchiectasis what the smooth meninges of the diagnosis of gastric intestinal lesions. So, too, is the diagnosis of those of kidney pelvis (hydronephrosis) compression by pneumothorax, pericardial section and thoracoplasty follow as early accurate diagnosis. I feel sure will greatly improve our results in its treatment. One result of compression of the name late importance is the treatment of bronchiectasis and not sufficiently well recognized is a pulmonary fibrosis which is largely responsible for the favorable results obtained from the acaplasty.

THE RELATIONSHIP OF CARCINOMA AND CALLOUS
GASTRIC ULCERBY W. J. MERRILL SCOTT, M.D., ILLINOIS CHRISTIAN UNIVERSITY
T. M. D. P. M. T. F. S. G. Y. F. H. S. H. I. F. M. I. U. T. Y. J. P. H. I.

WHEN Cruveilhier first distinguished gastric ulcer from carcinoma he mentioned their occasional coexistence in the same stomach. For 50 years they were thought to have little or no connection with each other. Then Zenker made the suggestion that gastric carcinoma might arise regularly from a preceding ulcer and in 1883 his pupil Häuser (47) published a careful pathological report illustrating this method of development. Just before the publication of this study of postmortem specimens how ever had begun the brilliant advances in gastric surgery which were soon to vitalize the question of a relationship between carcinoma and chronic gastric ulcer. Billroth reported the first successful resection of the pylorus for carcinoma and Woelfler introduced gastro enterostomy in the same year 1881. Gradually surgeons learned that a number of cases following gastro enterostomy for an indurated gastric ulcer died later of carcinoma of the stomach (Rodman 70 and Mayo 59). Furthermore in specimens of resected stomachs on microscopic examination carcinoma was found in many cases where the history and operative findings had led the surgeon to make the diagnosis of benign chronic ulcer. This frequent association of the clinical syndrome or the gross picture of chronic gastric ulcer with histological cancer stimulated several surgeons and some pathologists to urge the frequency of carcinoma ex ulcere.

This idea was for a time received favorably. It is true that a Lyons group headed by Tripi er and Duplant described a variety of gastric carcinoma characterized by extremely slow growth, chronic ulceration and clinical symptoms mimicking chronic gastric ulcer (80 and 31). This type they named *ulcus rodens gastrique*. They felt that the lesions showing both carcinoma and ulcer were ulcerated primary cancers rather than the carcinomatous degeneration of a benign ulcer. But the demonstration of a chronic gastric ulcer in

the walls of which carcinoma cells were found was frequently advanced as adequate proof of carcinoma ex ulcere. And some went so far as to assume that gastric cancer usually arose upon an ulcer basis.

However by a critical pathological study of the benign and carcinomatous ulcers the following points were gradually established: (1) Localized infiltrating carcinomata often become ulcerated. (2) Such lesions have the typical gross appearance of a chronic gastric ulcer. (3) In certain are is all of the malignant cells may disappear. (4) Usually when cancer cells are found in ulcers they are distributed in different parts of the latter which is evidence in favor of primary ulcerated cancer rather than a carcinoma developing in one part of a chronic ulcer. (5) The scar tissue base of the chronic ulcer entirely replaces the muscle layer while the carcinoma cells in ulcer like lesions usually infiltrate between some preserved muscle bundles. (6) In order to demonstrate the probable development of carcinoma from an ulcer it is necessary to find such a scar tissue base not infiltrated with carcinoma (Stewart 75 and Spilsbury 74). Applying such criteria for a pre-existent ulcer to a study of the specimens showing carcinoma Aschoff (4) and Stromeyer (76) concluded that there was evidence of the malignant degeneration of chronic gastric ulcer only in a small percentage. Dible in a very critical pathological study has recently confirmed this opinion (26). From such investigations we may conclude that carcinoma of the stomach does not usually arise from a preceding chronic ulcer. If the application of these pathological studies stopped here they would have served to critically readjust an unsupported hypothesis. But from them the apparently obvious corollary has been deduced by several that the danger of carcinoma need scarcely be considered in the clinical diagnosis and treatment of chronic gastric ulcer. This point of view was recently expressed



Fig. 1. Gastric carcinoma (X4)

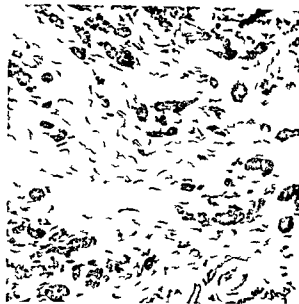


Fig. 2. Gastric carcinoma (X4)

for example by Morley in the symposium of the British Medical Association on carcinoma of the stomach (62). After quoting Dible's pathological studies he concludes:

In event of such comparative rarity (the malignant degeneration of chronic gastric ulcer) should not influence us then unduly either in the diagnosis of gastric carcinoma or in the treatment of gastric ulcer. This same sense of security is expressed even more forcefully by the action of many physicians in instituting a protracted dietary treatment in cases that clinically appear to be chronic gastric ulcer.

There have grown up then two diametrically opposed points of view in regard to the relationship of carcinoma to callous ulcer in the stomach. Cabot and Adie have recently summarized this protracted discussion (15). The issue debated have been the occurrence and frequency of the development of gastric carcinoma from gastric ulcer. This controversy over the pathological mechanism has tended to obscure rather than to emphasize certain facts of fundamental clinical impor-

tance. In the treatment of every case diagnosed as chronic gastric ulcer the question that must first be answered is: What danger is there that this condition may now or later be malignant?

Two patients who were in the Peter Bent Brigham Hospital at the same time illustrate the clinical importance of this problem. Similar examples could as easily be taken from the experience of all physicians and surgeons who follow up the end results on their cases diagnosed as chronic gastric ulcer.

CASE 1. J. M. S. P. B. B. H. Surg. No. 0006 male aged 58 admitted October 3, 1933 with the complaint of vomiting. The present illness began 5 years previously with epigastric distress after meals which had increased in severity. There was relief by food and soda and the discomfort was accentuated by dietary restriction. Two years previously periodic vomiting had begun occurring every 3 or 4 weeks at first but in the last year coming about every 10 days. The vomitus never contained fresh or old blood. For 9 weeks he had been on a milk diet which had relieved the epigastric distress but he did not prevent the periodic vomiting. Apparently he had been excellent and he had acute hunger on the milk diet. He had had no tar stool except on one occasion immediately after the extraction of all his remaining teeth. He had always had a tendency to constipation which had been greatly accentuated in the last year. He had lost only 10 to 15 pounds even with the reduced diet and vomiting and had continued to work throughout.

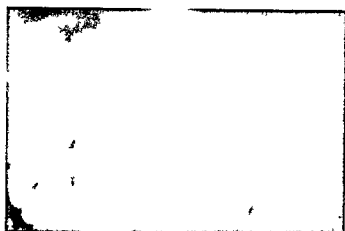


Fig. 4. Case 3. X-ray of the stomach. Niche on the lesser curvature.

At operation November 3, 1933 (by Dr. Cheever and Scott) before the Boston Surgical Society, a small ulcer of the lesser curvature was found. It was surrounded by extensive induration which reached nearly to the pylorus (5 centimeter) but did not occlude the orifice. The induration suggested malignancy and partial gastrectomy (Billroth II) was performed. Also a small nodule 3 millimeters in diameter on the anterior surface of the duodenum, 1 inch past the pylorus was removed. Frozen sections were made particularly on account of this anomalous nodule on the duodenum. The pathologist reported on the frozen section that the gastric ulcer was benign but that the nodule from the duodenum was an adenocarcinoma. However, when the fixed sections were obtained the pathological report was revised. The nodule of the duodenum was an aberrant pancreatic nodule and the gastric ulcer showed definite carcinomatous infiltration in the base (Figs. 1 and 2). No metastases were found in the glands.

The patient had an uneventful convalescence and was discharged November 10, 1933. He had gained 20 pounds and was feeling perfectly well in June 1925. Since then it has been impossible to obtain any information concerning him.

CASE H. E. L. I. B. B. H. Surg. No. 20179 female aged 65 years admitted November 3, 1933 on account of epigastric distress, anorexia and vomiting. For the past 30 years she had had periodic attacks of epigastric distress after meal, relieved by soda, by induced vomiting and sometimes by food. No hematemesis. The attacks were more frequent in the last year. For the past 6 weeks anorexia and vomiting have been marked. Vomitus contained food taken 4 to 48 hours previously. The past history is irrelevant.

Physical examination showed no cachexia and only slight loss of weight. The abdomen contained no masses but there was peristalsis seen in the epigastrium.

X-ray studies showed an atonic dilated stomach with vigorous irregular peristaltic waves. The outline was smooth except in the antrum where the

Fig. 3. Case 1. Adenocarcinoma in callous ulcer base. Note infiltration of carcinoma acini between mucin bundles (X40).

The past history is irrelevant. Physical examination demonstrated moderate loss of weight. The heart had a systolic murmur well transmitted. The abdomen was scaphoid, soft and contained no masses. The liver was not enlarged.

Leucocyte 17,000, hemoglobin 90 percent. Urine negative. On account of the vomiting gastric analysis was not done but the vomitus showed an excess of free hydrochloric acid and a negative benzenide test.

X-ray examination revealed a dilated atonic stomach of smooth outline everywhere except at the pylorus where there was a concentric narrowing involving the sphincter. There was irregular and reversed peristalsis in the stomach and nearly complete 6-hour retention. The interpretation was obstructive lesion at the pylorus which may be either carcinoma or ulcer.

The consensus of opinion before operation was that the lesion was a cicatrizing gastric ulcer with pyloric stenosis though the possibility that it might prove to be a carcinoma could not be excluded. Dr. Cheever's note of November 4 states: "The picture is a characteristic one of benign pyloric stenosis due to cicatrizing ulcer and I think that probably a Finney pyloroplasty will be the best treatment."

much rarer. The following case seems to belong in this latter small group.

CASE 3 C H B S M H No 4368 male 34 1/2 66 admitted December 11 1926 with the complaint of pain in the stomach. The present illness began 12 years ago with epigastric pain coming on 3 hours after meals and always relieved by food and soda. With periods of remission it has bothered him since on et. In the last months the pain has been exactly as previously except that it has come about hours after meals. Seldom has he vomited and never had hematemesis or melena. He has had no loss in weight Wassermann reaction has been strongly positive and he has had energetic antilutic treatment for over a year. X-ray showed a penetrating ulcer niche on the lesser curvature with vigorous peristalsis elsewhere (Fig 4). No 6 hour residue.

Blood hemoglobin 80 per cent urine negative stool formed brown microscopically no red blood cell guaiac test negative (gastric analysis fitting free hydrochloric acid 18 per cent total acidity 46 per cent. After Ewald meal 45 minutes free hydrochloric acid 16 per cent total acidity 43 per cent 75 minutes free hydrochloric acid 5 per cent total 76 per cent).

The pre-operative diagnosis was callous gastric ulcer there was no positive indication of malignancy.

At operation on December 18 1926 (by Dr Scott) a penetrating ulcer with a crater about 1.5 centimeters in diameter and 1 centimeter deep was found. There was nothing to suggest malignancy the base of the ulcer was adherent to the pancreas. Partial gastrectomy (Iowa Moynihan) was performed and the area where the ulcer was attached to the pancreas was cauterized. Convalescence was uncomplicated and the patient was discharged January 15 1927. He has gained 15 pounds and has remained symptom free to the present (May 1927).

The gross specimen showed a typical callous ulcer with no suggestion of malignancy. The edges were firm but not abnormally indurated. The proximal edge was overhanging and the distal one was terraced.

On section the base of the ulcer was formed of scar tissue which entirely replaced the musculature and showed merely the usual evidence of chronic inflammation (see characteristics of chronic ulcer Fig 7). In one area however there was a definite small zone of adenocarcinoma which spread out from the hyperplastic mucous membrane at the edge of the ulcer (Figs 5 and 6). This did not infiltrate the scar tissue base at a distance. In other sections carcinoma was not found. After the discovery of this one area of definite carcinoma 8 blocks were cut from various areas of the uncut half of the ulcer. In none of them was there any trace of carcinoma (Fig 7). It was felt therefore that the specimen fulfilled the exacting pathological criteria of a carcinoma arising presumably upon a pre-existent ulcer.



Fig 5 H H magnification of section outlined in Fig 4 showing a cluster of carcinoma acini (X 60).

Although we feel that this is an illustration of carcinoma ex ulcere its clinical significance is the same as if carcinoma cells had appeared in multiple places in the ulcer. Its chief interest lies in the fact that it appeared clinically to be an uncomplicated case of chronic gastric ulcer both before and at operation yet it proved to be carcinomatous.

The history was a typical ulcer story of 12 years duration. The gross appearance of the ulcer gave no suggestion of malignancy. In fact it appeared so evidently benign that no photograph of the gross specimen was made. Without the histological findings or if the first sections had been cut only from the half of the ulcer which by chance was cut later after finding the isolated carcinoma focus no one would have thought it anything but a typical callous gastric ulcer which had penetrated sufficiently deeply to become adherent to the pancreas.

INCIDENCE OF CARCINOMA IN CALLOUS ULCER

The clinical importance then of the relationship of carcinoma and chronic gastric ulcer is not dependent upon the development of the former from the latter but lies in the impossibility of the certain clinical differentiation of the two conditions. This difficulty is not reflected in the hospital records. When malignancy has been found in the resected specimen carcinoma of the stomach appears as the final diagnosis and the diagnostic problem is buried in an analysis of cases under the heading of carcinoma of the stomach with a positive ulcer history. Before operation though the case is a chronic gastric ulcer and when the microscope does not reveal the mistake it often remains on the records as only a chronic ulcer the patient dying elsewhere of carcinoma. It is extremely difficult to disentangle from a statistical presentation of cases the data that will present in a true light this clinical dilemma of the differentiation of benign callous ulcer and ulcer carcinoma.

The reports based upon cases only diagnosed clinically and not operated upon have limited value on account of (1) the difficulty in being certain that an ulcer is present (2) the confusion of duodenal and gastric ulcers and (3) the difficulty in determining the final outcome. I have found no report of a series of cases with convincing X-ray evidence of gastric ulcer followed over a sufficiently long period of time (at least 5 years) from which to derive data as to the proportion of chronic gastric ulcer cases that eventually prove to be carcinomatous.

Nielson's study of the end results of medically treated cases clinically ulcers deserves mention although X-ray evidence is largely lacking (6). His selection of cases included only those in which there was good evidence of organic disease though a large proportion of them must have been duodenal rather than gastric ulcers. Of 221 11 died of gastric carcinoma and 1 other had carcinoma in the part of the stomach resected later. Thus of the total series 5.4 per cent were subsequently proven to have carcinoma of the stomach. This would probably correspond to about 5

per cent of the true gastric lesions as duodenal ulcers are at least 4 times as numerous as gastric in the clinics. All but of the cases developing carcinoma had had symptoms for less than 6 years (15 per cent of the 66 cases of chronic ulcer with such a limited duration of symptoms).

This study of medically treated ulcers although unsatisfactory for statistical analysis on account of the lack of X-ray evidence still definitely demonstrates again the danger of carcinoma proving to be present in cases clinically diagnosed as benign ulcer. Joslin (49) also reports a 6 per cent mortality from carcinoma in the combined series of gastric and duodenal ulcer.

Suppy (71) emphasizes the necessity of watching for the evidence of a carcinoma as a possible complication in all case of gastric ulcer but he gives no statistical figure. Smithies (75) emphasizes that many authorities deriding the danger of carcinoma in gastric ulcer are deriding chiefly with duodenal rather than with gastric ulcers and he adds that he always feels nervous about the outcome of a true gastric ulcer until a laparotomy has determined the location and nature of the lesion. This deficiency in regard to exact reports of the late results of medically treated gastric ulcer in part is due to the fact the X-ray localization has only been of great help in the last 15 years and in part because internists have come to realize increasingly that the medical treatment of true callous gastric ulcer is unsatisfactory and dangerous (Alvarez 1).

Although more exact statistical reports of the evidence of carcinoma in medically treated chronic gastric ulcer are lacking its danger is amply attested by the large number of lesions diagnosed as benign ulcer after careful clinical study that prove upon operation to be carcinomatous. In the examination of resected callous ulcers clinically benign carcinoma was found in the following per cent: Moynihan (64) 18 per cent, Larr (68) 26 per cent, Kuettner (50) 30 per cent, Finsterer (38) 21 per cent, von Haberer (43) describe the diagnostic difficulty at operation after exposing the lesion as follows: Five per cent mistakes how many doubts! Morley

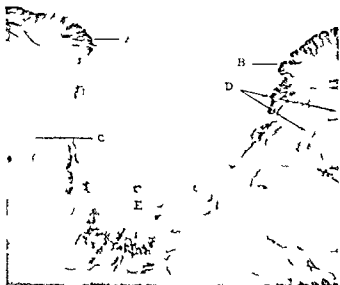


FIG. 1. Case 3. Typical chronic indurated ulcer. Note overhanging edge A, somewhat truncated rim B, completely interrupted C and D, and inflammatory scar tissue base E ($\times 15$).

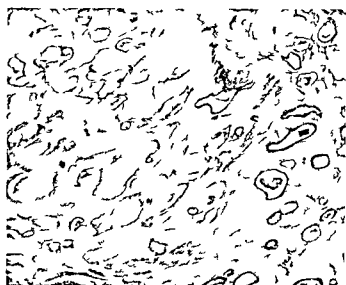


FIG. 2. (a) Photomicrograph of a colloid carcinoma with foci of a callous ulcer. Note the presence of acellular material within muscle bundles ($\times 15$).

although willing to dismiss the danger of carcinoma from consideration in the treatment of gastric ulcer received a pathological diagnosis of definite carcinoma in 10 per cent of 50 specimens considered by him even after they had been removed to be simple gastric ulcers (61). Aschoff who is extensively quoted is an opponent of the frequency of carcinoma ex ulcere expressed surprise at the large number of resected specimens resembling in form the ordinary round ulcer but proving microscopically to be carcinomatous (4). Maillon (56) reported that in 1400 resected ulcers clinically benign 18 per cent were found to be carcinomatous on histological examination. From these statistics of many clinics it would seem to be a conservative estimate that in 10 to 20 per cent of the chronic gastric ulcers there is a carcinoma actually present whether it has arisen from a chronic ulcer or has been from the first a primary carcinoma with secondary ulceration.

Another line of evidence corroborate this significant proportion of indurated ulcers that appear benign but prove malignant. An actuarial study of the life expectancy of patients operated on for duodenal and gastric ulcer at the Mayo Clinic was made (6 and 8). The death rate in the succeeding years was not above the normal expectancy after operations for duodenal ulcer but was over 3 times

this figure after operations for gastric ulcer (1 per cent mortality in 31 years). The most important factor causing this was the development of gastric cancer. In 180 patients followed for an average of 3.6 years after operation for gastric ulcer there were 105 deaths at least 75 of which were determined as due to carcinoma and many more in which the data was inconclusive probably died of this cause. Upon a careful re-examination of the specimens classified as ulcer at operation from patients dying subsequently of gastric carcinoma it was found that half of them showed evidences of malignancy that had been overlooked (Balfour 8). Also Anchueta (9) reports death from gastric carcinoma in 8 to 11 per cent of cases of calloused ulcer followed 3 years or more and in 334 gastroenterostomy for ulcer of the stomach and duodenum von Eiselsberg (33) found that in 41 remote deaths 15 were known to have been due to carcinoma of the stomach a probable incidence of 15 to 20 per cent in the true gastric ulcers. It is quite impossible certainly to differentiate benign calloused ulcer from carcinoma at operation sometimes after examination of the resected specimen and occasionally even histological study of the ulcer does not settle the question. Eggleston (5), Wilensky and Thalheimer (85) Mayo (60)

DISCUSSION OF STATISTICAL RESULTS

There are many reports based upon more or less carefully analyzed clinical material in which the conclusion is reached that carcinoma is an infrequent finding in gastric ulcer. Opposed to this view is the opinion from many surgical clinics that carcinoma is a very frequent finding in callous gastric ulcer. This apparent contradiction is in some instances of each opinion due merely to careless diagnosis either clinical or pathological. But even in the most carefully studied cases the same difference of opinion is recorded. This is more apparent than real however. In the medical series are usually included those cases that have symptoms suggestive of ulcer many of short duration and most of which are not verified by demonstration of the lesion. The surgical group is made up almost entirely now of indurated ulcer of long standing. By operation the existence and the character of the lesion have been demonstrated. A careful pathological study of such resected specimen has entirely changed our opinions concerning the life cycle and the degenerative and regenerative processes of chronic gastric ulcers. Crohn Weiskopf and Aschner (20). The apparently opposing views are consequently dependent largely upon the types of cases studied and often from the data included in report of non operated case it is extremely difficult to be certain what varieties of ulcer the author is reporting. It is generally accepted now that acute or subacute gastric erosion frequently heal and remain healed under proper medical treatment that consequently such lesions should not be operated upon except for their complication and that they are not precursors of carcinoma. Crohn Weiskopf and Aschner (21). Such acute ulcer syndrome are much more common than is the chronic indurated ulcer. Moynihan (64). On account of their inclusion as well as that of other lesions that are not chronic gastric ulcers (especially chronic duodenal ulcer) in the group of medically treated patients the danger of carcinoma in true callous ulcers is sometimes hidden in the reports of such lesions. Especially is this true if both gastric and duodenal ulcers are included in one study under the designation

peptic ulcer a term which of itself implies a lack of sufficiently exact data for accurate localization. For properly evaluating the dangers and the results of treatment in the much less frequent chronic gastric ulcer these should always be presented in a separate group distinct from acute gastric ulcer and from duodenal ulcer. In order to clarify the diagnosis and the type of lesion in future analysis of cases it would be of great assistance if gastric ulcer were classified some what as Cushing () has grouped brain tumors.

CLASSIFICATION

For use both in the hospital records and in the reporting of case of gastric ulcer I propose the following classification:

- I Gastric ulcer—suspect
- II Gastric ulcer unverified (carcinoma suspect)
- III Gastric ulcer verified
- IV Carcinomatous gastric ulcer verified

Under each of the first 3 headings determine whether acute (non indurated) or chronic (indurated).

Gastric ulcer suspect includes all cases in which a tentative diagnosis of gastric ulcer is made. In the localizing evidence to distinguish between gastric and duodenal lesion is often lacking and so the 2 groups may be placed together as peptic ulcer suspect if so desired. It is only in this group however that this non localizing term peptic would be permitted. Many in this group prove later to have no ulcer at all but to have ulcer mimicking symptoms from pylorospasm gall bladder disease etc. The peptic ulcer suspect cases should not be included in a consideration of gastric or duodenal ulcer except as regard the differential diagnosis. Moynihan (64) has illustrated the great importance of basing the study of gastric ulcer upon those cases proved by X-ray or operation to have an ulcer.

Chronic gastric ulcer unverified includes those cases that have definite signs of localization in the stomach as well as ulcer symptoms sufficient to establish the diagnosis clinically. Specifically the clinical picture should be supported by X-ray or operative evidence compatible with indurated gastric

ulcer These lesions are always carcinoma suspects

Chronic gastric ulcer crified includes only those cases having histological evidence of an indurated ulcer. If carcinoma is found in the ulcer it places the lesion in the class of proven gastric carcinoma but in order to have the ulcer like malignant lesions available for study it would be advisable to name them Carcinomatous gastric ulcer and cross file them both under carcinoma and under chronic gastric ulcer

It is now at once evident that most of the gastric erosions the acute gastric ulcers must necessarily fall in the group of gastric ulcer suspects as usually there is not sufficient localizing data to justify the diagnosis of gastric ulcer unverified. Very rarely can they be classed as acute gastric ulcer verified since most of them disappear under medical treatment. In the earlier days of gastric surgery operation was frequently performed for such ulcers without finding any definite lesion.

If the cases are reported under such a classification it at once forms a basis for comparison and analysis such as does not now exist in many of the reports of gastric ulcer. I believe it will quickly dispel the appearance of disagreement in regard to the danger of carcinoma occurring in cases diagnosed clinically as callous ulcer of the stomach.

Including only those cases having had ulcer symptoms for several months and showing X-ray evidence of a gastric lesion compatible with ulcer 10 to 20 per cent of such chronic gastric ulcers unverified will prove to be carcinomatous.

TREATMENT AND RESULTS

As a direct and specific corollary of this fact, all cases of chronic gastric ulcer ought to be considered and treated as carcinoma suspects. Nearly all writers agree that a suspicion of malignancy is an urgent indication for radical surgical treatment of a chronic gastric ulcer (Alvarez 1, Bevan 10). From the cases and evidence cited above it seems that the symptoms of chronic gastric ulcer constitute such a suspicion of malignancy and consequently except for positive contraindications to operation the lesion should prompt-

ly be removed (Douglas 8, Finsterer 36). Lahey (51) advises the hospitalization and medical treatment of such cases for 2 weeks. At the end of that time he decides upon the basis of relief of symptoms, the absence of occult blood and decrease in the size of the X-ray niche whether the lesion is benign. If these criteria are not favorably affected he operates. This is a big improvement over the previous method often used of ignoring the danger of carcinoma or of heeding it only when positive clinical signs of malignancy have developed. When an ulcer shows such a change in symptoms with constant pain, emaciation and an acidity it usually means the extension of the malignant process so that the chance for surgical cure usually is already gone (Cheever 18, Cheney 19, Masson 56). Even the method advocated by Lahey however does not with certainty differentiate malignant from benign lesions in the early stages. A carcinomatous ulcer may for a time show partial healing, great improvement in symptoms and absence of occult blood (Dieulafoy 27, Hurst 48, Eusterman 34). Consequently it seems to me to be the safest course to regard all callous gastric ulcers (as defined above) as potential cancers. One of our prominent gastro enterologists emphasizes this point thus: "If the physician lets him (the patient with chronic gastric ulcer) drift on with medical treatment he assumes a tremendous responsibility" (Alvarez 1). If this point of view can be inculcated into both the profession and the laity the outlook would be greatly improved in this ulcer mimetic group which constitutes about one fifth of the gastric carcinoma and we should have made a stride forward in the percentage of curability in this form of carcinoma. Twenty years ago carcinoma of the stomach was regarded as having practically a hopeless prognosis (Friedenwald 40). Today there are a number of 15 and 20 year cures so that we are certain that the prognosis is not hopeless (Wegele 8, Basch 9) and in cases that can be resected there is a 10 to 31 per cent 5 year freedom of recurrence (Ansuetz 3, Finsterer 37, Hartmann 45). Our immediate hope of improving the results in gastric cancer lies in operation while complete removal of the

malignant process can be carried out (Cheever 17). There are 2 definite lines of progress toward this end which have in common the treatment of patients above the age of 35 with gastric complaints as carcinoma suspects unless the latter can be ruled out (Blackford 11). In one group are those that in middle life or later without any obvious cause develop some vague gastric symptoms or general asthenia and loss of weight (Goldie 41 Master 57). Such cases are to be carefully investigated as possibly having carcinoma of the stomach and if necessary for its exclusion an exploratory laparotomy should be performed (Deaver 25 Dunham 30). The other group is that of the indurated gastric ulcers. These cases can never be differentiated clinically as certainly benign (Smithies 7). X-ray examination does not distinguish between the carcinomatous and the benign gastric ulcer except in the late stage (Carman 16 Baetjer and Friedenwald 5). Surely hypo acidity is no criterion as Hartman (46) has emphasized. Probably it is true as Nielson (65) contends that the greatest number of carcinomatous ulcers are among the group with ulcer symptoms for less than 6 years. That this is no sure criterion however is evident from our Cases 2 and 3 and many other examples in the literature. Thomas (78) has also called attention to the relative infrequency of an ulcer producing an hour glass stomach being malignant. This immunity is only relative however. A callous gastric ulcer removed at any stage of its clinical course may prove malignant (MacCarty and Broders 53). MacCarty (55) has pointed out that those over

5 centimeters in diameter are usually carcinomatous. This is true but as Alvarez (1) remarks even when the crater is small the patient cannot be assured that he has not a carcinoma and the aim of medical practice should be the diagnosis and eradication of the carcinomatous ulcer before it has reached such a large size. For this purpose the cooperation of the internist and the surgeon is necessary in diagnosing the potentially carcinomatous lesion from early symptoms and in educating the laity to this danger. The time to attack the malignant gastric ulcer is in the months or years before signs of malignancy

have arisen and while the ulcer symptom only are present (Ginsterer 35).

The exact prognosis in this group of chronic carcinomatous ulcers cannot be separated satisfactorily in the literature from that of localized carcinoma of the stomach in general. There are available too few cases with correlated clinical and pathological findings together with the end result. It is surely clear however from example of such case reported that the prognosis is dependent upon the extension of the lesion beyond the stomach (Lusterman 34 MacCarty and Blackford 52). Even in spite of delays of months or of years many such cases have had clinical cures (Peck 69 Hartmann 45).

On account of the danger of carcinoma the operation of choice for callous ulcer in the distal half of the stomach is partial gastrectomy. Balfour (7) has advocated cauterization. He reports 130 partial gastrectomies with 4 deaths subsequently from carcinoma (3 per cent) and 96 cauterization with 10 later fatalities from carcinoma (3.3 per cent) each apparently followed by the same risk of carcinoma recurrence. However as he suggests the larger ulcers are not satisfactory for treatment by local excision consequently a greater proportion of the more extensive carcinomatous ulcers are probably included in his resected group. So it seems that these groups are not comparable for statistical purposes. Pauchet (67) reported better results from partial gastrectomy than following cauterization.

My personal observations though not sufficiently extensive to be conclusive have led me to the conviction that partial gastrectomy if technically feasible is far superior to any form of local excision. Two lesions of this type which were thought to be benign chronic ulcers were liberally excised with the cautery. Both recurred one 2 years and the other 4 years after operation. Both of the recurrences seemed favorable. In fact at operation there was nothing to suggest that they were malignant carcinoma being found only by histological examination and no other case of recurrences after cauterization apparently. The former have given 4 years (Case

6 years without evidence of recurrence. The most important item in the operation is the wide excision of the glands of drainage with the resected portion of the stomach. While in most cases a margin of 4 to 5 centimeters past the indurated tissue is ample to prevent local recurrence in the stomach itself (Thalhimer and Wilensky '77) the operation should remove particularly the glands of the lesser curvature (Hartmann '44). In order to include these most of the lesser curvature is excised in the resection. For re-establishing the gastro intestinal canal Moynihan's modification of the antecolic Polya operation ('64) has given us most satisfactory results. The immediate postoperative recovery is surprisingly smooth and the functional result is excellent. Wheeler ('84) also remarks about how little postoperative reaction there is from this procedure. The mortality of such a resection for chronic ulcer is little if any greater than after local excision (Moynihan '64 1.6 per cent Finsterer '35 2.3 per cent). If there is extension of obvious carcinoma outside of the stomach requiring formidable accessory procedures such as resection of the colon, the pancreas or the liver, the operative mortality mounts (Finsterer '39). Such mortality statistics have no bearing upon the risk of resection for lesions that appear to be chronic ulcer. Partial gastrectomy then offers the only chance of cure for the lesion that is obviously malignant at operation and also the best chance of cure with a very low mortality for the callous ulcer in the pyloric half of the stomach.

HISTOLOGICAL TYPES REPRESENTED

All types of carcinoma are found histologically in these callous ulcers. Carcinoma simplex was illustrated in Case 1 and adenocarcinoma by Cases 2 and 3. Colloid carcinoma is less frequently found. In its early stages there is nothing to distinguish it clinically or in the gross from other carcinomatous ulcers. The following case illustrates this variety.

L. G. O. S. M. H. No. 3404 male aged 43 was admitted to the hospital November 4, 1926 with the complaint of pain in the epigastrium and vomiting. The present illness dated back 2 years when he

began to vomit once a day, not accompanied by pain or nausea. After 1 year this subsided for several months. For 3 months before admission he had had epigastric pain or 3 hours after eating relieved by vomiting or alkali. Vomitus had been of a coffee ground variety at times. Loss of 13 pounds had taken place in the last 3 months. Examination revealed some emaciation. Stool showed no occult blood.

Gastric analysis: fasting free hydrochloric acid 9 per cent, total acidity 20 per cent. After Ewald test meal free hydrochloric acid 10 per cent, total acidity 27 per cent. Gastro intestinal X ray showed irregularity in the pyloric antrum (lesser curvature) and a 6 hour residue.

The pre operative diagnosis was gastric ulcer. At operation November 5, 1926 (by Dr. Morton) a large callous ulcer was found on the lesser curvature. Before resection there was no definite proof as to whether the lesion was benign or malignant. Its size (3 centimeters in diameter) and the inflammation around it suggested on gross inspection that it would prove to be a carcinomatous ulcer. Sections of the lesion showed colloid carcinoma infiltrating deeply into the base of the ulcer (Fig. 8).

Whatever the type of cell, all of these malignant callous ulcers share the characteristic of ulceration nearly co-extensive with the malignant proliferative process. In fact, the typical gross picture of chronic ulcer with an undermined oral edge and a terraced distal margin is frequently found. In the base or the edge of the ulcer the carcinoma cells may be very abundant or may be found only with difficulty. Thomson and Graham ('79) and also Thalhimer and Wilensky ('85) have each reported a case in which multiple sections failed to demonstrate any carcinoma but in which the latter was found in the lymph glands. Usually cords of malignant cells invade the base, infiltrating between the muscle bundles. Sometimes however the carcinoma is confined to one area with a typical ulcer scar, most of which is uninvaded by the malignant process. This latter is the only type which Dible considers. Clinically it cannot be differentiated from the primary carcinomatous ulcer (Dahl Iversen '23 and Duplant '31) and its prognosis is the same. There is no definite correlation between cell type and prognosis (Brodnitz '14, von Haberer '43 and Weil '83) except that the colloid carcinoma usually spreads throughout the peritoneum and if the stomach is removed before the malignant cells reach the sero a

there is less danger of lymphatic metastasis having already occurred (Deaver 24 and Duggan 9) The results of resection of the stomach however do not show any great difference in colloid carcinoma from the other types (Farham 66)

Recently Broders (12) established a correlation between the degree of malignancy and the histological differentiation of cellular structure of carcinoma of the lip This principle has been found to apply in certain other malignant tumors (Greenough 42) Carcinoma of the stomach also has been studied from this point of view by McCarty and Mahle (34) and Broders and McCarty (13) There is a slightly longer survival in the group showing the greatest cellular differentiations but this correlation is not nearly as important as in carcinoma of the lip and breast

SUMMARY

Historically there has arisen a controversy over the malignant degeneration of chronic gastric ulcer This protracted debate concerning the pathological mechanism has detracted attention from the significant clinical fact that there is a type of carcinomatous ulcer which mimic exactly chronic gastric ulcer in its symptomatology and physical and X-ray manifestations

As Niel on state the point of view of the surgical pathologist should be that one can never be too reserved when dealing with the diagnosis of *carcinoma ex ulcer* However of far greater importance to the patient the point of view of the clinician (both the internist and the surgeon) should be one can never be too certain in the differentiation of chronic gastric ulcer from carcinoma

As there is no sure way of distinguishing clinically between the benign and malignant callous gastric ulcer all such ulcer ought to be considered and treated as carcinoma suspects The doctor who temporize with chronic gastric ulcer may be robbing that individual patient of cure and in opposing the education of the laity in regard to the early diagnosis and radical treatment of gastric conditions that may be carcinomatous The hopeful phase of the treatment of gastric cancer is the radical removal of the lesion

before the development of the classical signs of malignancy In a large number of gastric carcinoma cases the lesion is inoperable when symptoms first manifest themselves The ulcer carcinoma does not fall into the above group but are characterized by symptom for months and often years before they are so extensive as to prevent resection

Pathologically such lesions seem usually to be slowly growing primary localized carcinomata in which the ulcerative process is nearly co extensive with the neoplasm In a small number however there is pathological evidence that the carcinoma has developed upon a true chronic ulcer the classical *carcinoma ex ulcere* These pathological type cannot be distinguished clinically and often not in the gross specimen

All type of carcinoma may be found in these malignant callous ulcers There is not sufficient data upon which to base a differential prognosis separate from other localized gastric carcinomata or according to the cellular type represented When resection is feasible it results in a 25 per cent 5 year free dom from recurrence

The difference of clinical opinion about the danger of carcinoma in chronic gastric ulcer seems to be due chiefly to the type of case studied A classification is suggested which will assist in differentiating similar group for comparison and in ruling out of consideration the large number with inadequate data for localization

Limited to those cases presenting ulcer symptoms over a period of months or years with definite X-ray evidence of localization in the stomach clinically diagnosed chronic gastric ulcer will prove carcinomatous in 10 to 50 per cent

CONCLUSIONS

1 The controversy concerning the development of carcinoma from chronic gastric ulcer has obscured the significant clinical relationship of the two conditions

It is frequently impossible to differentiate clinically the malignant from the benign callous gastric ulcer in the stage when cure is still possible It cannot even be done with certainty in many cases

3 As a corollary to this fact all callous gastric ulcers are carcinoma suspects and should be treated as such both before and at operation

I want to express my appreciation to Dr Harvey Cushing and Dr David Cheever for permission to include in this report the cases which I studied at the Peter Bent Brigham Hospital. I am indebted for the photomicrographs to Mr A P H Travels of the Eastman Kodak Company.

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DIFFERENTIAL DIAGNOSIS OF AMÆBIC DYSENTERY AND CHRONIC ULCERATIVE COLITIS BY PROCTOSCOPIC EXAMINATION¹

By LOUIS A. BUIE, M.D., ROCHESTER, MINNESOTA

S t P oct 1 gy M 3 Cl

AMÆBIC dysentery like chronic ulcerative colitis produces certain characteristic and unmistakable lesions in the rectum and sigmoid. Their appearance in many instances even when repeated stool tests are negative has provided sufficient evidence for a positive diagnosis. Those who are conversant with this disease know that such remedies as ipecac and its derivative emetin hydrochloride and the arsenicals such as treparol, stovarsol and arspenamine will often cure the diarrhoea and cure ulceration to heal within a period of 10 days. Such medication constitutes therefore a valuable therapeutic test which we often employ when stool examinations are negative although the ulcers are typical. The diagnosis has been uniformly confirmed by healing of the ulceration after treatment. Often when *entamoeba histolytica* cannot be demonstrated in the stool it will be found in great numbers in the scrapings taken from the bases of the ulcers.

In the general run of cases the ulcers are discrete and the mucosa between them although not normal is so mildly inflamed as to seem relatively uninvolved. Of course in many cases of active diarrhoea due to *entamoeba histolytica* the rectal and sigmoidal mucosa is normal or but slightly hyperemic. However when the ulcers appear they are typically discrete and have no characteristics which might lead to confusion with any other type of rectal ulceration unless it is certain types of tuberculous ulcers and those associated with *balantidium coli*. As compared with chronic ulcerative colitis the ulcers of amœbic dysentery even in its earliest stage are not as small nor as numerous they are much deeper and in the severe cases they increase in size. In chronic ulcerative colitis the military ulcers do not increase in size with severe attacks (although they become more numerous) and the large 'secondary infective' ulcers seen as associated are not to be considered as a part of the characteristic picture.

The amœbic ulcer usually occupies a position on the prominent folds of the bowel wall or involves the valves of Houston. The margins are undermined by the infiltration of the ulcerative process and the prominence of the ulcer is further increased by the accumulation on the base (composed largely of great numbers of *entamoeba histolytica*) and projecting above the ulcer margin presenting itself as a greyish white covering over the center of the ulcer known as the white cap. This term is familiar especially to those who live where the active disease is more prevalent. The white cap is easily swabbed away after which the true base of the ulcer is revealed lying below the surface of the overhanging margins. This is the explanation of the punched out or umbilicated appearance of the amœbic ulcer. It varies in size from about 2 or 3 millimeters in diameter (rarely so small) to a large sloughing ulcer to 3 centimeters in diameter (or larger) with irregular margins and overhanging ragged edges seen usually higher in the colon. In the cases seen in the Mayo Clinic both of these extremes are rare the usual ulcer is about 3 to 5 millimeters in diameter and there is usually a small zone of hyperæmia surrounding it. Of course in the acute cases with severe prostration and excessive stools sloughing and bleeding it will be difficult to identify any such ulcer the involvement is massive and diffuse and a single ulcer is seen only in the midst of a sloughing bleeding mucosa. Such extensive disease is rarely seen in the Mayo Clinic because it is almost entirely associated with acute tropical amœbic dysentery which is seldom observed here. Experience in the Clinic has been with the more chronic type and it is possible that this high percentage of cases with relatively uninvolved mucosa between the ulcers might not be duplicated in the experience of others especially in those localities in which the acute forms of the disease are predominant. During the course of any year in the Clinic the stools of about 6

per cent of the patients registered are examined and *entamoeba histolytica* is found in about 10 per cent of the cases. Brown in studying a series of cases of amœbia is at the Mayo Clinic divided them into three groups as follows

Group 1 153 cases 8.1 per cent in which active symptoms dysentery or liver abscess were manifested at the time of admission. In 34 per cent of these cases rectal ulceration was found on proctoscopic examination

Group 2 58 cases 48.3 per cent in which the chief complaint or one of the complaints was intermittent pills of diarrhœa some times alternating with constipation. Associated with this there were usually reflex abdominal symptoms borborygmus and in definite lower abdominal distress. In none of these was rectal ulceration present

Group 3 12 cases 8 per cent in which the *entamoeba* was found without recorded history of dysentery. These were the pure carrier cases. They were discovered in the careful study of patients in whom all possible sources of infection were sought which might be factors in conditions such as dermatitis, anemia and indeterminate intestinal disease.

A comparison of the rectal and sigmoidal lesion of amœbic dysentery with that of chronic ulcerative colitis shows that they are not alike in any particular except that both represent forms of ulceration and inflammation of the colon. They should be confused only in the massive diffusion of the severer cases. However even then if the individual elements entering into the composite picture are analyzed it will be seen that they are alike in no particular. In amœbic dysentery the ulcers are discrete and seldom smaller than 2 millimeters, coalescence being present only in the very severe cases. In chronic ulcerative colitis diffusion is a feature in all cases from the mildest to the most severe (acute or chronic). The characteristic military ulcers occur in much greater numbers and are seldom larger than 1 millimeter in diameter. The active period of the disease is characterized by stages of diffuse inflammation, œdema, military abscesses and military ulcers. From the bases of the ulcers a specific type of organism (described by Bargen) can be isolated. The dis-

ease is prone to begin in the rectum and extend upward. There are often larger ulcers present but these are due in all probability either to the invasion of the smaller ulcers by secondary infective organisms or continued activity of the diplococcus described by Bargen possibly both of the factors are responsible. The ulcers in no way resemble those caused by *entamoeba histolytica*. The former have irregular margins without the undermining and a shallow base which is covered by a tenacious membrane which does not heap up. In such cases on rare occasions *entamoeba histolytica* has been obtained on examination of the stool but scrapings from these ulcers did not show the organism and the therapeutic test has failed to incite healing. In fact the arsenicals often increase the activity of the disease in cases of chronic ulcerative colitis.

In many instances the characteristic ulcers will heal either during a period of quiescence or after a course of vaccine treatment leaving small pock like scars behind as evidence of previous activity. The secondary ulcer however does not always respond to the vaccine and the resultant picture of pock like scars between the larger ulcers is just as significant diagnostically as the original ulcers were.

Another point of contrast is the constant tendency toward uniform tube like contraction of the lumen of the bowel in chronic ulcerative colitis. This is seen both on proctoscopic examination and on roentgenograms of the colon made after barium enema. In my experience such contraction is seen but rarely in amœbic colitis. The diameter of the bowel therefore tends to return to normal after the amœbic ulceration has been displaced by treatment except in chronic cases following repeated severe attacks. In the very severely affected bowel of amœbic dysentery there is also distention and scarring but it does not result in the uniformly narrowed pipe like colon seen after attacks of chronic ulcerative colitis. The tendency in most cases of the latter is for the contraction to remain permanently although recently we have seen some restoration of the normal lumen after vaccine treatment.

The existence of such a disease as chronic ulcerative colitis is far from being universally admitted. In some comparatively recent and comprehensive descriptions of diseases of the colon it is not specifically mentioned. Current articles sometimes pass it over. Many clinicians insist that it is an aberrant form of bacillary dysentery from which the typical organisms cannot be isolated, and cases have been recorded of the successful use of polyvalent antidyenteric serum.

The pathology of the disease is confusing because the postmortem appearance is radically different from the sigmoidoscopic manifestations. By the time death occurs the mucosa is almost entirely destroyed and in the bloodless tissue all traces of the distinguishing features of the disease are lost.

Descriptions of the lesion as seen through the sigmoidoscope are conflicting. It has been described as recognizable at first glance as indistinguishable from that of bacillary dysentery and as presenting a clear cut clinical and pathological picture by different authors and by the same author. In the course of more than 20,000 sigmoidoscopic examinations since 1919 I have examined more than 600 cases of chronic ulcerative colitis. I have observed what I consider the typical lesion in the untreated state and during its progression and its healing under treatment. My description (4) is therefore not based on an occasional observation but on constant manifestations not presented by any other known disease.

Hurst has been unable to observe this type of lesion and fears that the disease in America is different from that seen in England. Indeed it was his suggestion that I might be confusing it with amœbic dysentery that prompted this paper.

I have not been able to find in the English literature a comprehensive description of the lesion as seen there through the sigmoidoscope. I can therefore make no comparisons. The clinical course however and the appearance at necropsy are practically the same here as in England.

Lockhart Mummery describes the appearance of the lesions at necropsy and under the sigmoidoscope and pays considerable attention to the larger and as I think less typical lesions—the size of a pea up to large irregular tracts. He suggests that the lesion seen with the sigmoidoscope is an earlier or milder stage than that observed at necropsy. He describes the former as granular and uses an illustration which is identical in many respects with my description.

The confusion that clouds the general attitude toward chronic ulcerative colitis will be cleared when observers of numbers of cases describe explicitly the appearance of the disease under the sigmoidoscope; then only will the chasm that lies between observation and conviction be bridged.

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OBSERVATIONS ON THE RATE OF URETERAL REGENERATION

PRELIMINARY REPORT

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THE problem of repair following ureteral injury became interesting to me some years ago when I witnessed in one of our charity hospitals three ureteral accidents in a period of 3 months. Since these occurred while the patients were under the care of a gynecologist of experience and unquestionable ability, it follows that similar injuries must be observed in other clinics where the same extreme pathology is encountered. It must be admitted that many ureters could be saved if ureteral catheters were passed and left *in situ* during difficult pelvic operations involving large inflammatory and neoplastic masses. On the other hand, even with the utmost precautions, ureteral accidents are apt to occur from time to time.

Opportunities to attempt ureteral repair are very few, even with surgeons having large private and charity services, with the result that our knowledge of ureteral healing is poor. That healing and epithelization does occur with any of the numerous methods of anastomosis is an established fact, but the rate is unknown. Our knowledge of the rate of healing of a severed urethra anastomosed over an indwelling catheter indicates a rapid and complete reestablishment of urethral continuity usually within 10 days, so that the catheter may be safely removed at that period. The tendency of an epithelial lined duct to regenerate along a splint in the biliary passages and also in the vis deferens is well known. In the latter the sheath alone may act as a bridge and regeneration may progress with reestablishment of the lumen.

The facts led me to believe that epithelization and repair of a severed ureter would occur with equal rapidity, and this conviction led to the experiments detailed below.

The three ureteral accidents previously mentioned occurred in the course of very difficult gynecological operations. Two of these happened during radical Wertheim operation for carcinoma of the cervix. In

both instances the ureters were exposed and followed down to the bladder only to be ligated accidentally when troublesome hemorrhage from the uterine vessels completely obscured the field of operation. In one case the patient developed a complete urinary and subsequent attempt to catheterize the ureters revealed bilateral occlusion. At autopsy these findings were confirmed. The second woman shortly after operation developed severe pain in the right renal region and cystoscopic examination revealed unilateral ureteral occlusion. Several weeks later nephrectomy was performed for hydronephrosis. The third accident was a complete severance of the ureter which had been displaced by a large pelvic inflammatory mass. Following the dissection and removal of the adherent mass the ureter was found to be cut just below the brim of the pelvis. An anastomosis was immediately done according to the method of Van Hook. Urine discharged from the peritoneal cavity the next day and continued until nephrectomy was performed several weeks later.

Buckham discusses 16 different operations for uretero-ureterostomy and all of the fall into one of two groups—end to end and end in end anastomosis. End to end anastomosis may be performed without a support by transverse (Schopf-Cushing) approximation of the ureteral edges. Boyce's oblique and Van Hook's elbowing anastomosis are other methods of end to end repair without a support. The Tuffier and Kelly method consists of suture over a ureteral support which is removed when the sutures are in place.

Markoe, Poggi, Kelly and others have described methods of end in end anastomosis which differ from each other only in detail. Van Hook's uretero-uretero-tomy by proximal ligation and end into side implantation is recommended by many as the best for all around use. Young advocates simple end to end suture over a ureteral catheter passed from the bladder to the renal pelvis.

McArthur described a method of ureteral repair which I found to be very well adapted for experiment on dogs. This author left his catheters *in situ* for a period of 9 weeks but he went on to say that although ureteral regeneration is known to occur the rate of epithelialization of the ureter is unknown. The method described below is similar to that described by McArthur.

The method of bridging with a ureteral catheter was used in these experiments because it seemed to be the method of choice in view of our knowledge of the tendency of epithelial lined ducts to regenerate over a splint. The purpose of this paper is to recount observations on the rate of ureteral regeneration and not to advocate the method described in preference to any of the other known methods.

In performing the operation the main difficulty has been to prevent tearing into the peritoneal cavity which usually caused the death of the dog within several days. The primary mortality was very high so that the series of successful operations was small. However a number of interesting observations were made which it is hoped will be confirmed and added to in future experiments which are being contemplated.

TECHNIQUE OF OPERATION

Ether anesthesia was used. The lumbar region was shaved and prepared with iodine and alcohol. An incision was made through skin, fascia and muscles to expose one kidney. The kidney was delivered and the ureter located and dissected downward so that the middle third was exposed. In this portion was made a longitudinal incision long enough to admit two No. 5 ureteral catheters. One catheter was passed upward into the renal pelvis, another catheter was passed downward into the bladder and the ends of both catheters were brought out through the wound. At a point $1\frac{1}{2}$ inches below the longitudinal incision the ureter was completely severed and the cut edges were brought together with one silk suture. The wound was closed by layers.

Experiment 1 The operation was performed according to the technique previously described. The

upper catheter began to discharge urine immediately and continued to do so until both catheters were removed on the fifth day. A urinary fistula developed in the wound and remained open for 3 weeks although the amount of urine discharged became progressively less. During the fourth week the fistula closed and the wound healed completely. The dog was killed 4 weeks after operation.

Postmortem examination four weeks following operation Necropsy revealed the kidney on the side operated upon to be one half the size of the opposite one and considerable subcapsular scarring was seen throughout. The peritoneum overlying the ureteral incisions was smooth and glistening and not thickened. Slight kinking of the ureter was noted but otherwise there was little visible manifestation of the ureteral anastomosis. Palpation of the ureter revealed peri ureteral fibrosis limited to the area of anastomosis and ureteral drainage. Fluid injected into the lower ureter passed the area of anastomosis without obstruction distending the pelvis of the kidney. Examination of the lumen showed two areas of constriction one at the line of anastomosis and the other at the point of longitudinal incision for insertion of the catheters. The latter was more marked. The mucosa in the involved area was grossly unaltered and only slight dilatation of the upper ureter and pelvis was noted.

Sections of the kidney revealed evidences of interstitial inflammatory involvement with only slight changes in the tubular and glomerular structures. Sections of the ureter in the area of operation were normal as compared with the other ureter except for rather marked peri ureteral fibrosis.

Experiment The technique of the operation was exactly as described. On the fifth day the catheter leading from the kidney pelvis was removed and the catheter leading to the bladder was left *in situ*. Previously urine drainage through and around the upper catheter was good. Following this a urinary fistula persisted until the time the dog was killed 2 weeks later. The general condition of the dog was good throughout this period.

Postmortem examination two weeks following operation The kidney on the side operated upon was one and one half times the size of the opposite kidney. The consistency was softer but otherwise the appearance was quite normal.

The peritoneal surfaces in the region of operation were smooth and glistening but some thickening could be palpated. The ureter in the area of the incisions was markedly kinked and imbedded in a mass of dense scar tissue. A fistulous tract was found in this mass extending from the ureter to the outside in which was found the lower catheter extending down the ureter to a point several inches above the bladder. The fibrous periureteral thickening was fairly well limited to the upper ureteral wound and fistulous region although it extended downward to the area of anastomosis where peri ureteral scarring was much less marked. The ureter above the fistula and the renal pelvis were definitely



Fig. 3. Section of the kidney of Dog No. 1. Magnification 100x.

dilated. A ureteral catheter pushed up the ureter from the bladder passed by the area of anastomosis making its exit through the fistula. Like the catheter passed downward from the renal pelvis emerged through the fistula.

When the ureter was opened along its entire course a fine annular scar with practically no constriction was found at the point of anastomosis. Above the point where the ureter was imbedded in scar tissue the lumen of the ureter was slightly constricted and communicated with the fistula. The upper portion of the ureter was dilated.

Microscopic section of the kidney and ureters were essentially the same as in the previous experiment except for a much greater amount of perireteral fibrosis.

Experiment 3. The usual technique was used with the following exception. Instead of merely severing the ureter about three-fifths of an inch was excised and the edges were allowed to remain the above distance apart over the usual ureteral splint. One loose silk suture was used to prevent further retraction of the ureteral edges. Urine began to be expelled from the upper catheter at once. Usual closure by laves followed.

On the fourth day both catheters were removed. Urinary fistula developed; the wound which continued to discharge urine until the dog was killed 3 weeks after operation. At that time a small clean fistulous tract remained and the general condition of the dog was good.

Postmortem examination. The following observations: Thickening of peritoneum overlying the affected region was noted with a few easily torn omental adhesions. Both kidneys were grossly similar as regards appearance and consistency.



Fig. 4. Ureter of Dog No. 1. Magnification 100x.

The affected ureter was thickened throughout its entire length. The site of the recent operation procedure was easily located because of the perireteral thickening and adhesion of the ureter to the surrounding structures. In this region (about 3 inches) the ureter wall in a mass of scar tissue. Above this point it was dilated to about one and one-half times the size of the ureter below. Dissection within the scarred area revealed perfect continuity, moderate fibrous thickening and very little kinking. In the area of cicatrization a small fistulous tract was discovered extending from the lumen of the ureter to the external wound. The silk suture was found in the lower portion of

the thickened scarred area thus locating exactly the site of ureteral regeneration

A ureteral catheter No. 4 passed upward from the bladder was obstructed at the site of anastomosis. Fluid injected through the catheter passed beyond the anastomosed area and escaped through the fistulous opening located about 1 inch above the point of obstruction. After the fistulous opening was closed with a purse string suture fluid injected with considerable pressure passed upward and distended the upper ureter and renal pelvis. Following the above procedure manipulation of the ureteral catheter resulted in its free passage by the affected area into the pelvis.

When the lumen of the ureter was opened the area of regeneration was found to be constricted to about one third the diameter of the portion below. This area measured about $\frac{3}{4}$ inch in length. About 1 inch above the internal orifice of the ureteral fistula was easily found. The upper ureter and kidney pelvis were definitely dilated. The mucous surface in the affected portion was similar in gross appearances to the adjacent portions above and below.

The three experiments cited were selected for report and discussion because they demonstrate results which appear to cast some light on the rate of ureteral regeneration and epithelization. It would appear that the tendency is rather to overrate the time necessary for regeneration and canalization of epithelial lined ducts. In 2 of the above experiments (1 and 3) the splints were removed on the fifth day and in both instances ureteral continuity with a patent lumen was reestablished at the time of necropsy 3 and 4 weeks later. In one of these (Experiment 3) a gap of $\frac{3}{4}$ inch was left between the severed ureteral edges while in the other (Experiment 1) the ureteral edges were approximated with only one suture. In these cases the amount of periureteral fibrosis was much less marked and the anatomical result much better than in Experiment 2 where the ureteral splint was left *in situ* for 14 days.

The evidence is very definite that ureteral repair and epithelization occur very rapidly since a perfect anastomosis was found in dog at the end of 14 days with the splint in position during the entire period. The fact that a successful anastomosis and canalization occurred after only 5 days of bridging should emphasize the probability of sufficient regeneration at that period to insure reestablishment of continuity and lumen even when a definite gap exists.



Fig. 3. Section of ureter of Dog 2 in the region of the anastomosis showing marked periureteral fibrosis.

lishment of continuity and lumen even when a definite gap exists.

In the literature on ureteral anastomosis great emphasis is placed on the prevention of leakage of urine at the point of anastomosis and the statement is frequently made that leakage retards or actually prevents ureteral healing. It would appear from these experiments that splinting is the more important factor although diverting the urine as was done with the upper catheter may have been an important factor in determining the rapidity of the healing of the severed ureteral edges.

The periureteral cicatricial reaction observed was in all probability caused more by the presence of the catheters than by leaking urine and infection. Rapid closing of the ureteral fistula occurred when the catheters were removed within 5 days demonstrating the desirability of a much shorter splinting period than that used by McArthur.

Some stenosis of the lumen may be expected with any type of ureteral anastomosis and is apt to be more marked if the method used resembles that advocated by McArthur. Stenosis should be combated by lowering the period of bridging thus diminishing the amount of periureteral scarring. Ureteral dilatation would appear to be indicated in all



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cases especially if a gap has previously existed. Dilatation should be performed as soon as possible because of the danger of contraction of the periureteral scar. The hydronephrosis and hydro ureter which is found in some degree following any ureteral anastomosis may be rendered less marked by timely ureteral dilatation.

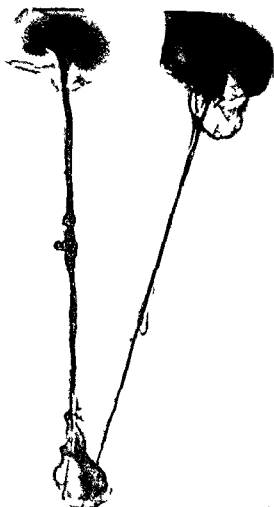
SUMMARY

1. Ureteral injury may occur during the course of difficult gynecological operations and during the operation indwelling ureteral catheters should be used as a precaution against such accidents.

Ureteral regeneration canalization and epithelization occur rapidly when a ureteral plug is provided.

3. The period of splinting or bridging should not be unduly prolonged because of the tissue reaction aroused by the foreign body. It appears that a splinting period of 5 days is ample to allow reestablishment of ureteral continuity.

4. Ureteral stenosis may be expected with every case of ureteral anastomosis and is



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more marked in cases in which an actual gap between the ureteral edges has previously existed.

5. Ureteral dilatation is always indicated following ureteral operations and should not be delayed too long.

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A CYSOMETRIC STUDY OF THE PHARMACOLOGY OF THE BLADDER

WITH ADDITIONAL DATA REGARDING THE PHYSIOLOGY OF URINATION

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F. M. D. J. M. T. S. G. Y. W. L. A. T. L. T. Y. M. I. L. H. I. B. H. P. T. I.

THIS work has been undertaken to determine the experimental value of the cystometer in the pharmacology and physiology of the urinary bladder as well as to furnish further proof of the correctness of the ideas of bladder innervation used to formulate the clinical principles of the instrument as given previously (4 and 5).

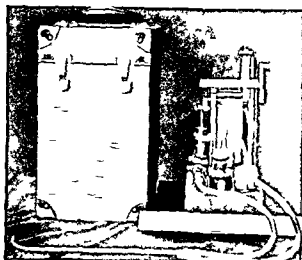
The cystometer (Fig. 1) utilizes the total innervation of the bladder in that as the viscous fills the changing capacity with its pressure is measured and a curve recorded between the bladder capacity in cubic centimeters of water and the intracystic pressure in millimeters of mercury. In all previous attempts to determine bladder function either isolated strips of muscle from different portions of the bladder have been immersed in solutions containing various drugs and their response recorded graphically or a given constant amount of water has been placed within the bladder the nerve supply of which is then stimulated either through dissection allowing direct electrical stimulation or by various drugs used hypodermically and the action of either type of stimulation determined by the contraction or relaxation of the bladder upon this given amount of fluid. Obviously this latter method is incorrect in that the bladder has no given capacity and to measure its changing size and tonicity it would be necessary during these changes to keep it completely filled. This is accomplished when the cystometer is used.

The work done so far in the clinical use of the cystometer has been based upon the fact that the bladder wall and its internal sphincter are chiefly in control of the sympathetic and parasympathetic nerves and that in general whenever sympathetic meets parasympathetic in a dual nerve supply to any organ or tissue the effects of the two are antagonistic (3). Upon stimulation the sympathetics with outflow from the second

dorsal to the third lumbar anterior roots passing by way of the inferior mesenteric ganglions and hypogastric nerves contract the internal sphincter and relax the bladder wall and are therefore considered the nerves of bladder filling whereas the parasympathetics from the second and third sacral segments form the pelvic nerves stimulation of which contracts the bladder wall and relaxes the internal sphincter and are therefore the nerves of bladder emptying. One other action has to be considered namely that of the external sphincter which is best considered as the resistance to the bladder wall external to the internal sphincter. The reason for this consideration is that there are in the so called external sphincter so many influences that no one muscle can be held responsible for this resistance (Chart 1).

In further explanation of this idea we have recently discovered in the clinical use of the cystometer an entirely new explanation for a type of urinary retention which occurs when the lesion irritates or destroys the innervation of the external sphincter muscles (nervus pudendus chiefly). We would in such instances have left a normal sympathetic and parasympathetic system but with a large retention due to the fact that the paralyzed or spastic levator prostatic (anterior portion of the levator ani muscle) will not institute the downward and backward motion of the prostate and bladder base necessary to its emptying.

With a cystoscope just at the internal orifice the trigonal portion of the bladder is seen to be pulled downward and backward (6, 7 and 8) when the patient is asked to strain as in voiding. The direct depression of the floor of the internal sphincter and the posterior urethral pull is due to the trigonal and in part to the recto urethralis muscle but the chief posterior and slightly downward motion is due to the levator prostatic portion of



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the levator ani muscle. In the normal male micturition is *voluntarily initiated* and in our analysis the first motion in the act of urination is this voluntary depression of the internal orifice and prostatic urethra and then the involuntary action of the trigonal portion of the bladder with which action the lateral walls of the orifice are relaxed by virtue of the loop muscles about it (6). The contraction of the trigonal muscle foreshortens the supramontane urethra and institutes the involuntary emptying contractions. Without the action of the levator prostate we have obstruction by virtue of the curve of the posterior urethra and its consequent angulation at the membranous urethra. *Voluntary retention* is made possible through the levator prostate by elevation of the internal orifice which effects an increase in the sharpness of the curve at the deep transverse perineal muscle and triangular ligaments thereby increasing the resistant pressure here.

Female dogs were used exclusively in this study. Each animal was anesthetized with paraldehyde by mouth 1.5 cubic centimeters per kilogram of body weight being used. The cystometric curves were made after the dog

was perfectly quiet which required from 30 to 90 minutes in time. They were catheterized with a 16 French female metal catheter. The urine was examined each time to be sure there was no infection. Several pressure readings were always made with each dog before the administration of the drug under consideration. Invariably the capacity of a dog's bladder is from 15 to 20 cubic centimeter more in the first cystometric examination than in any subsequent curve. We attribute this to the stimulation of the first filling resulting in an increased tonicity of the bladder wall. The same observation is easily made when irrigating the human bladder in which the patient almost invariably tolerates a much larger amount of the irrigating fluid the first time than during the several succeeding fillings. After the first reading a more or less definite capacity and intracystic pressure is established which is maintained quite in definitely. One of these later cystometer curves we consider in each case as the normal intracystic pressure. At this point the drug under consideration is administered. The bladder is filled by the cystometer with sterile water at a constant slow rate of filling. When the limit of capacity is reached the fluid is expelled around the catheter. This point is marked on the curves presented as 1 f c (voids around catheter). The drugs were given in the order of their description and with definite times allotted between their administration.

In Chart the inhibitory effect which atropin has upon the parasympathetic nerve is first shown. The reading starts with a zero pressure in an empty bladder and gradually mounts to 8 millimeters of mercury with a 55 cubic centimeter capacity. Having established a normal curve we gave atropin 1/120 grain subcutaneously. Ten minutes later the terminal capacity had increased from 55 (in the normal) to 90 cubic centimeters of fluid and the terminal pressure had decreased from 28 (in the normal) to 18 millimeters of mercury. We consider this distinct evidence of parasympathetic inhibition. Immediately following this reading pilocarpin hydrochloride 1/5 grain was given subcutaneously and 6 minutes later a reading

D K ROSE CYSTOMETER CHART

C C OF FLUID

Hendrickson -

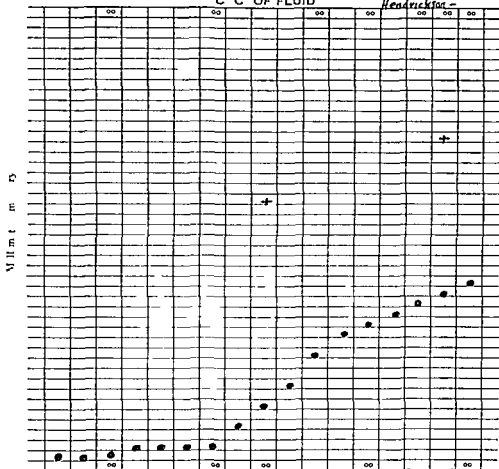


Chart Dots show the intravital pressure during contraction of the bladder wall line. Cc's show the volume of fluid in the bladder. The earliest cystometric point are (1) normal friction to 100 cubic centimeters (2) only slightly delayed contraction point at 400 cubic centimeters (3) large capacity with mounting pressure and without evidence of catheter (4) high voluntary intravital pressure—milligrams at 40 cubic centimeters—and 60 milligrams at 100 cubic centimeters (5) low initial bladder pressure due to large residual urine effect in bladder wall (6) muscular decomposition (7) low emptying pressure taken as each third of the bladder emptied (8) showing unusual decomposition of the bladder wall. In summary we have no normal exertion therefore no normal automatic both type of first void in the same vesicles decomposition of the wall but with more than sufficient voluntary pressure necessary to empty the bladder. Such a complex suggests bladder neck of tract on as the voluntary emptying through catheter of good force. Cystoscopic examination was negative except that when present at the floor of the internal sphincter did not move forward and backward the motions brought about by the atropine muscle. Cystometric diagnosis lesion of anterior roots low cord. Operation was done by the first catheter operation state. Conus inserted under the tenth spinal process at the exit of its roots and studding them many small masses resembling tubercles were found. No specimen removed.

showed that the pressure and capacity had both been decidedly changed. This definitely indicates the antagonistic action of pilocarpin which is a parasympathetic stimulant.

The degree of antagonistic action in Chart is better understood by comparing it with Chart 3 in which the normal pressure having

been established as indicated on the chart to cubic centimeters of 4 per cent cocaine solution was introduced within the bladder. This resulted in a marked relaxation of the bladder muscle which represents in degree the condition present when a cocaine solution is used prior to urethral or bladder manipulations.

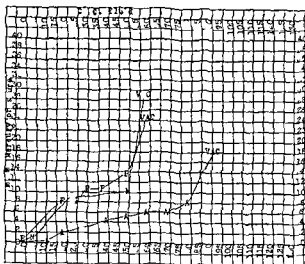


Chart 4. Normal Pilot Pilocarpine

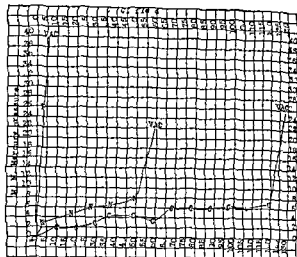


Chart 5. Normal Pilot Pilocarpine

is a local anæsthetic that is decreased tone of the bladder wall indirectly lessens pain as well as the local sensory action of the anæsthetic used. Immediately following pilocarpine hydrochloride $\frac{1}{5}$ grain was given intramuscularly resulting in an overwhelming stimulation of the parasympathetic.

Epinephrin is one of the most important drugs we have in the study of the sympathetics. Elliott (2) believes its action in dogs and cats is different in that he finds no inhibitor fibers in dogs whereas they are definitely present in cats. We feel that they are undoubtedly present in man and in our work are shown to be present in the dog. We believe that epinephrin in small doses causes contraction of the bladder in large doses relaxation.

In Chart 4 after establishing the normal we gave 1 cubic centimeter of 1:1000 epinephrin intramuscularly and obtained full stimulation of the sympathetics in that the voiding around catheter point remained high and the capacity of the bladder increased showing a stimulant action of the sympathetics i.e. inhibition of the bladder fundus and stimulation and contraction of the internal sphincter.

In Chart 5 the action of small doses of epinephrin is demonstrated i.e. bladder contraction following the intramuscular injection of 0.5 cubic centimeters of 1:1000 solution. If with this type of reaction the motor portion of the sympathetics could be cut out

we should then have left the amount of relaxation resulting from stimulation of the inhibitor fibers. Dale (1) carried through this idea with the use of ergotoxin and for the same purpose we have used ergotamine tartrate (trade name Gynergen). Immediately after recording the epinephrin curve 0.001 grams of ergotamine tartrate was given intramuscularly and we obtained a markedly increased capacity with lowered intracystic pressure as shown by the chart. This is of particular interest as in subsequent charts ergotamine tartrate not influenced by epinephrin produces distinct contraction of the bladder and in this case we can deduce only that the sympathetic inhibitors stimulated by the epinephrin are left in major control the motor sympathetics being cut out by ergotamine tartrate.

Acetylcholin stimulates the parasympathetics and when used immediately following ergotamine tartrate we find its definite influence as we would expect i.e. a lowered capacity and a lowered voiding around the catheter point or in other words contraction of the bladder and relaxation of the internal sphincter upon which the counteraction of the motor sympathetics is cut out.

To test further the value of this method and to check the action of these drugs Chart 6 is presented in which the administration of ergotamine tartrate and epinephrin is reversed in order. The normal curve was established which in this particular instance was

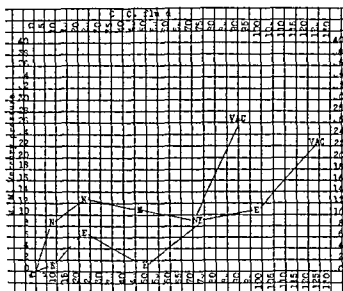


Chart 4 A Normal E epinephrin

of an unusually large capacity with low pressure. Following the injection of 0.00 grams of ergotamine tartrate intramuscularly, a curve was recorded after an interval of 10 minutes which showed an abrupt contraction of the bladder. Immediately afterward 1 cubic centimeter of 1:1000 epinephrin was given and 4 minutes later a curve was made which showed its antagonistic action to ergotamine tartrate by the distinctly increased capacity. However, there remained a residual high intracystic pressure from the ergotamine tartrate.

In Chart 7 a further composite picture is recorded in that after establishing the normal pressure 1 cubic centimeter of pituitrin was given intramuscularly producing bladder wall contraction by its direct action upon the muscle. Following this 1 cubic centimeter of a 1 per cent solution of curara (approximate strength) was given intramuscularly. The animal soon became flaccid and with slowed jerky respirations. Five minutes after the curara was given curve C was recorded which shows an increased capacity to 195 cubic centimeters with a voiding around the catheter pressure of 30 millimeters of mercury. This increased capacity probably represents a direct action of the curara on the bladder musculature. Following the curara by 10 minutes 0.00 grams of ergotamine tartrate was given. There was a slight decrease in the capacity so that in 10 minutes 0.003 grams

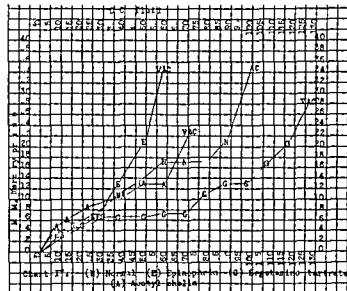


Chart 5 A Normal E epinephrin G ergotamine tartrate in a titration

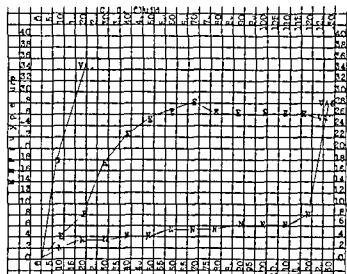
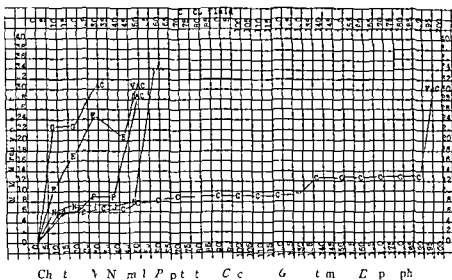


Chart 6 A Normal G ergotamine tartrate E epinephrin

more of ergotamine tartrate was given and 3 minutes from this time we obtained the curve recorded here that is a marked contraction of the bladder. Again following the ergotamine 15 cubic centimeters of 1:1000 epinephrin was given intramuscularly and in 4 minutes there was some release of the bladder contraction in that the capacity increased to 50 cubic centimeters. It was noted following this that there was a very slow settling to the base reading which is indicative of sympathetic stimulation. The settling to the base line is much more rapid after parasympathetic stimulation.



CONCLUSIONS

1 The cystometer furnishes a new method for studying the physiological and pharmacological actions of the bladder

Results obtained by various drugs corroborate very satisfactorily the basic principles used in clinical cystometric work

3 Atropin acts as a parasympathetic inhibitor while pilocarpin acts as a parasympathetic stimulator Epinephrin in small doses causes contraction of the bladder and in large doses causes relaxation Acetylcholin is a parasympathetic stimulator Pituitrin produces increased bladder wall tone

4 The antagonistic pharmacological action between drugs can be beautifully demonstrated the same antagonistic action has been found clinically in certain types of diffuse cord lesions

5 Through the clinical use of the cystometer the following steps in the complete physiology of micturition in the male have been evolved (a) Voluntary depression of the internal sphincter and prostatic urethra by the levator prostatic muscle (to a less extent

by the recto urethralis) its assistance in opening the internal orifice straightening out the curve of the posterior urethra and thereby lessening the resistant angle at the membranous urethra which is compressed by the deep transverse perineal muscle (b) Contraction of the trigonal muscle further opening the orifice by depressing its floor and foreshortening the posterior urethra (c) Contraction (or parasympathetic action) of the bladder wall i.e. a contraction instituted by or with the contraction of the trigonal muscle and having associated with it the relaxation of the loop muscles of the internal orifice

W h t l b t d t H S G l k J T ry
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E i r r R R J Phyl 1 90 x 3/
3 J H C y g C & O b t 9 x 346
4 J D k J m M A 9 1
5 Id m J U l 48
6 W M B J l 1 9
7 y d W s y h S u g 9
8 y i d M r r J l h m l & L p Th p
9 4 x 3 5

THE FORM CHANGES IN THE HUMAN UTERINE GLAND DURING THE MENSTRUAL CYCLE¹

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THE external appearance of the glands of the corpus uteri and their changes in form during the menstrual cycle have not been adequately visualized. The methods previously used, namely, the study of serial sections and in one case of wax plate reconstruction (Baumgartner, Nelson and Dock, 1920) have been more or less adequate for the interpretation of the simpler gland forms but they do not give any conception of the great variability in the form of the complicated glands of the later stages of the uterine cycle.

The classical description of the uterine gland presented a slender tubule coursing perpendicular to the surface and ending simply or after dichotomous division at the tunica muscularis. Sinuosity of occasional glands was accepted as normal.

Leopold (1877) correlated the slender tubular glands with the period immediately following menstruation and recorded their transformation into sinuous or alveolated glands as the succeeding menstrual period was approached. From our present point of view his carefully selected cases proved that such changes are normal but there were not many of them and the time was not yet ripe to establish correlations. It remained for Hirschmann and Adler (1908) to demonstrate the cyclic significance of the transformations undergone by the endometrium.

Opitz (1899) although cognizant of Leopold's work, described the papillary appearance of the hyperplastic uterine gland in early decidua and regarded it as diagnostic of pregnancy. While admitting the constancy of the papillary type of gland in pregnancy, Hartje (1907) pointed out that it is also regularly found in non-pregnant uteri during the period preceding menstruation. Hirschmann and Adler (1908) with a wealth of material at their disposal showed that the so-called decidual glands regularly occur in the period preceding the menstruum and proposed them as one of the criteria of what they term the

premenstrual stage. It was not until their work was understood that C. Ruge's endometritis glandularis came to be regarded as a normal stage of activity.

The portion of the endometrium lost at menstruation and the form of the remaining glands have received extensive consideration. It was said by Hirschmann and Adler and verified by Iwase (1906), Schroeder (1914) and others that the mucous membrane incurs little loss upon the first day of menstruation, the maximal sloughing of the functional layer (namely that portion of the mucous membrane which hypertrophies for the implantation of the ovum) occurs upon the third day, usually at this time only the basal portions of the glands remain. Usually the fourth day shows the beginning of regeneration (Schroeder) and the fifth day a continuous surface epithelium overlying a low functional layer containing short straight reconstructed glands. Hirschmann and Adler (1908) and others have questioned the loss of tissue at menstruation in some cases.

METHODS AND MATERIAL

Our method utilizes free hand sections 0.1 to 0.2 millimeter in thickness cut with an auto-stop razor blade from material in 80 per cent alcohol after prompt fixation in Zenker stock solution or the like. The sections are iodized, washed and stained in Delafield's hematoxylin (before the addition of methyl alcohol and glycerin) diluted one part to five of water and one drop of glacial acetic acid added per 2 cubic centimeters of the diluted hematoxylin. The sections should be agitated occasionally to insure even staining. They are passed through tap water, dehydrated, cleared in oil of wintergreen (synthetic) and mounted in balsam. This method recommended by Professor R. R. Bensley (Goetsch, 1910) gives an adequate idea of the external form of even the complicated pre-gravid glands and makes possible a rapid sur-

¹ This work was supported by the University of Chicago.

vey of every part of an entire endometrium. Such a survey usually demonstrates regional differences which may not be neglected. It is a valuable, rapid method of diagnosing pathological material.

Observations upon thick sections such as these were confirmed by the study of whole gland dissected from pieces of fresh mucous membrane which had been placed in one third concentrated hydrochloric acid and macerated for 12 hours (Schweigger-Seidel 1865). The work has also been controlled by a detailed study of thin sections.

Three hundred specimens which in the fresh state showed little or no gross pathology were selected from those removed in the clinic during the course of 3 years. These were either entire uteri or frequently only fundi. The majority of these specimens showed some evidence of infection but such mild stroma inflammations do not appear to affect the glands as is obvious from a comparison with uninfected material. From this abundant collection sixteen mucous membranes have been selected as representing typical phases of the uterine cycle as described by Schroeder and others.

CLASSIFICATION

The first study of the duration of the menstrual cycle based on records established with scientific accuracy (King 1906) confirms the early finding of Foster (1889) and makes it obvious that the regular twenty-eight day cycle is very much of a fiction. King studied 17 women and kept accurate records for from 12 to 104 cycles in each case. The duration of the cycle of a given individual was found to vary about a single mode but the actual variability in duration of cycles was from 24 to 35 days although there is a distinct mode in the curve for all cycles studied at 27 to 28 days. Such findings accurately established mean that the statements of the average woman as to the usual duration of flow have very little scientific value.

More important is the fact that the various subdivisions of the cycle cannot be accurately fixed. Even in successive cycle of the same individual corresponding days after the flow are not necessarily exactly comparable and specimens removed on corresponding days of

the cycle may show marked differences from one to another especially as to the form and secretory activity of the gland.

Schroeder's scheme of the menstrual cycle outlined and illustrated by photomicrograph in his *Lehrbuch der Gynaekologie* (cf. Evans in Barker's *Endocrinology and Metabolism* vol. II and Williams' *Obstetrics for a sum*) is at present the most satisfactory basis for subdivision. It may be summarized as follows:

1. *Proliferative phase*. Fourth or fifth to fourteenth days of the cycle. Slender tubular glands with high columnar epithelium. Progressively increasing mitotic activity in both glands and stroma. Correlated with the ripening of a new graafian follicle.

2. *Secretory phase*. Fifteenth to twenty-eighth day. Glycogen mucicarmine positive material and fat appear in the gland cells and then in the lumen. The glands become sinuous or saw-toothed. Stroma cell enlarge superficially. The vessels hypertrophy. Correlated with this phase is the development of the corpus luteum.

Schroeder's term secretory as applied to this stage is not distinctive. As Bartelmez (1907) has found that secretory activity is not continued to this period. As I Meyer has pointed out premenstrual is very misleading. Pregnant is much more satisfactory and will be used throughout our description.

3. *Desquamatory and regenerative phase*. First to fourth or fifth days of cycle. Following leucocytic invasion and pyknotic in the superficial mucous membrane extravasation of blood and desquamation occur. Re-epithelialization soon follows. Correlated with this phase is the degeneration of the corpus luteum.

We shall follow this except that it seems advisable to us to subdivide the last phase separating the desquamatory and reparative processes. The latter intervenes between the first signs of re-epithelialization and the formation of a complete surface epithelium.

This scheme of Schroeder's based upon his own material of over 700 cases and several hundreds more from the literature serve as a norm according to which specimens may be classified by their resemblance to a given stage of the cycle regardless of the length of the menstrual period, duration of flow and

other variable features. Thus the fifteenth day of a thirty five day cycle may resemble the tenth day of the Schroeder classification and is thus regarded as belonging to the beginning of the proliferative stage. This provides also for those specimens removed after a 6 or 7 day menstrual flow which upon the fifteenth day of the cycle for example are likely to be more retarded than mucous membranes from cases with a 3 day flow at the last period.

DESCRIPTION

Early proliferative phase CC 148 thirteenth day. The mucous membrane varies from 12 to 30 millimeters in thickness as measured in 80 per cent alcohol.¹ With the exception of a thin strip of lamina basalis (Schroeder) adjoining the muscle the entire stroma has the appearance of granulation tissue. The glandular epithelial cells are high columnar and in the early stage of secretory activity. Mitosis is active in both the gland epithelium and the stroma. Occasional lymphocytes, eosinophiles and plasma cells are to be found in the stroma. The appearance of a histological section of a similar stage is shown in Figure 1 (CC 51 eleventh day).

The glands are sparse or moderately abundant and show little variation in form (Fig 2). They are slender cylinders with narrow lumina which expand uniformly from narrow superficial foveolæ toward the tunica muscularis at which they end in slight expansions or after branching in short vertical tubules. Bifurcation may occur in the basal half of the mucous membrane and is occasionally found superficially as well (Fig 2 Br 1).

From the portions of the glands surrounded by the denser fibroblastic stroma of the lamina basalis vertical tubules (Fig 2 BB) arise which project for varying distances into the granulation tissue stroma of the functional layer and which have no connection with the surface. However since they reach a much greater length in older mucous membranes we may assume that they eventually reach the surface and establish new glands thus serving to increase the number of glands in later

stages. Such outgrowths from the basal zone have not been previously recognized and we would suggest calling them *basal buds*.

CC 288 twelfth day. The mucous membrane is 19 to 21 millimeters thick and presents a later stage in that the stroma is composed of more mature connective tissue than in the preceding specimen. The gland cells are in the early phase of secretory activity. Mitoses are observed in both the gland and stroma elements. Plasma cells, lymphocytes and leucocytes are observed.

Figure 3 shows entire glands from this endometrium isolated by acid maceration. The typical form of the early proliferative stage is seen. The basal ends of some glands branch irregularly and slender basal buds may spring from the portion of the gland in the lamina basalis and extend a variable distance toward the surface (Gland 1 BB). It will be noted that the glands are somewhat more irregular than in the previous case and are more plump in form.

Late proliferative phase CC 141 fifteenth day. The mucous membrane is 18 millimeters thick. In early phase of secretory activity is common in the glands and there is no evidence of the storage of glycogen. Mitoses occur in both the gland epithelium and the stroma. Lymphocytes are the chief infiltrating cells and there are a few small lymph nodes. The stroma reticulum (cf Sekiba 193) has differentiated through the entire thickness of the mucous membrane whereas in the two specimens previously described it was not present in the superficial granulation tissue.

Figure 5 taken from a thick free hand section of this mucous membrane shows moderately abundant straight glands which branch basally. Corresponding to the increase in thickness of the mucous membrane the glands are longer. Basal buds (BB) are a conspicuous feature. They are somewhat dilated with secretion and have grown considerably farther into the overlying stroma than in the previously described cases. A study of serial sections of this specimen demonstrated that the basal buds are not connected superficially either with other glands or with the surface furthermore the mitotic figures in such basal buds proved they were actively growing.

All bseq t t t m t f th th l f th m m mb h
 Th y w m d m t m d th m t l a s pe t l h i
 l bl d m t na t w th p l m y y f h t
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We have here the clearest evidence as to the way in which the number of uterine glands might be increased twofold in the course of a few days. To be sure this specimen might be regarded as a very early phase of hyperplasia but except for the numerous basal buds it appears perfectly normal. Figure 4 presents a photomicrograph of a thin section from a similar specimen.

Early pregravid phase CC 61 twentieth day. The mucous membrane is 3.0 millimeters thick. The epithelium is still in the early stage of secretory activity. The stroma is composed of mature connective tissue and is permeated by reticulum fibers. Mitotic activity has decreased compared with specimens from the twelfth and thirteenth days. There is evidence of mild infection. Figure 5 is a photomicrograph from a section of similar histological appearance.

The changes in gland form which initiate the pregravid period are presented in Figure 7 which is a photomicrograph of a free hand section. The glands have widened until the lumina are wider than one-half the diameter of the gland. While some of them are almost straight (*gl 1*) most of them have become sinuous (*gl 2*) or symmetrically sacculated in form. In other parts of the mucous membrane and in other specimens the first appearance of wavy or irregular gland form is found in the basal one-third (*gl 3*). Slender horizontal tubules arising from the bases of the glands branch extensively and there is some evidence of connections between tubules from adjacent glands. Two basal buds (*BB*) close to the surface and dilated with secretion were observed. Since mitosis was still active they would probably have reached the surface and not have become cystic glands.

CC 66 twenty first day. The mucous membrane is 3.0-4.5 millimeters thick. The gland epithelium is in the early stage of secretory activity. Mitotic activity is considerably diminished. Figure 8 is a photomicrograph of a free hand section illustrating the meandering course of a majority of the glands.

The next specimen cannot be regarded as normal but many of the glands were perfectly typical and can be used to illustrate the form of the pregravid gland.

CC 98 thirty ninth day. The epithelium is not in the typical pregravid phase of secretory activity but contains abundant glycogen. Mitotic activity is markedly diminished compared with the preceding specimens of the proliferative phase. The stroma is however edematous and the histological picture is that of the early pregravid phase. Cystic glands are not infrequent and their presence may be regarded as an early stage of hyperplasia. The degree of infection is slight. It is included here because particularly good isolated glands were obtained.

Figure 9 shows several such entire glands isolated by acid maceration. Transition are manifest from the slender round sinuous glands to the complex sacculated and folded ribbon-like types. Gland 1 is a basal bud which had not reached the surface and was dilated due to accumulating secretion. Figure 10 shows a ribbon-like gland photographed from two sides. Note the difference in appearance and the ease with which different interpretations of the same gland might be made depending on the plane of section in which it was cut.

Late pregravid phase CC 143 twenty third day. The mucous membrane is 2.8-4 millimeters thick. It is typical of the pregravid (Schroeder's secretory) stage (Fig. 11). The superficial stroma is somewhat edematous and contains many enlarged cells of the decidual type. While there are many gland cells which are not actively secreting there are other which are at the height of the secretory activity typical of the pregravid phase. It presents a normal histological picture and agrees closely with our other pregravid specimens and also with Schroeder's (1926) Figure 44 taken from the twenty sixth day. A normal corpus luteum in full bloom was obtained from this case.

In view of the descriptions of pregravid glands given by previous workers their form is surprisingly irregular. In occasional groups of glands the slender shape of the proliferative phase is retained and the only evidence of pregravid change in their form is a slight rugosity in the walls. In many there is a slender neck prophetic of the neck of the decidual gland opening into the uterine lumen.

Below the neck region the lumen is greatly dilated and the gland is more irregular. Here we find a flattened sinuous shape sometimes complicated by minor irregularities. In a few glands the walls are symmetrically sacculated. The lamina basalis is narrow and contains the slim branched tubules which represent the gland bases. Figure 1 presents a typical group of glands from this specimen.

CC 69 thirtieth day. This specimen is at the height of the pregravid phase. There is evidence of accumulation of glycogen and intense secretory activity. The superficial one half of the endometrium is very edematous but there is no evidence of blood extravasation or accumulation of leucocytes so characteristic of the period immediately preceding menstruation. There are many cells of the decidual type in the superficial stroma.

The glands present a very variable appearance. The most advanced forms are shown in Figure 13. In the superficial one third they have a narrow lumen and are wavy or may be irregular or spiral in form. A few continue as narrow spirals but many of them are expanded so as to appear as narrow folded ribbons (cf Fig 10) reaching a diameter of 0.5 millimeter near the lamina basalis. There are in other words transitions from early forms of pregravid glands to most complex types characteristic of end of menstrual cycle.

Menstruation. Distinct reduction in secretory activity characteristic changes in the walls of the blood vessels and extravasation of blood into the stroma inaugurate a process of necrosis. It is still a matter of debate as to whether all of the functional layer is lost at each menstruation. The process at no time involves the lamina basalis however which itself may be of considerable thickness.

CC 107a first day. The mucous membrane is 1.9-3.0 millimeters thick. Many glands still show secretory activity. As a result of the accumulation of extravasated blood the superficial stroma is loosening and disintegrating leaving the necrotic free ends of the glands to project into the lumen of the uterus.

The glands are crowded (Fig 14). While a few retain a slender wavy cylindrical shape throughout the majority are oval in cross section and variable in width. Where the lumen

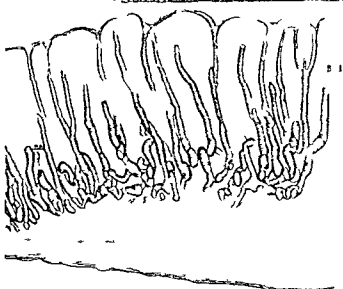


Fig. 1 (above) CC 51 eleventh day. Photomicrograph of an 8 μ section from an endometrium in the early proliferative phase. Characterized by numerous mitoses and a stroma resembling young granulation tissue. $\times 2$.

Fig. 2 CC 148 thirteenth day. A group of glands drawn from a thick free hand section of an endometrium in the same stage as that of Figure 1. Note slender glands branched basally and basal buds (BB) arising from the gland of the lamina basalis and directed toward the surface. $\times 19$.

is considerably enlarged the glands appear as folded bands narrow at base but wavy. Many are irregular in form even at this level.

CC 83 first day. The mucous membrane is 2-3.1 millimeters thick. The glands resemble an early pregravid type and show little evidence of secretory activity. The superficial one half of the mucous membrane upon one side of the uterus is necrotic and sequestering

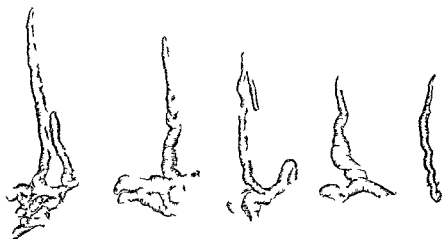


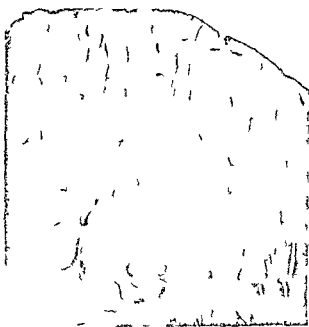
Fig 3 CC 88 tv lth d y A f hol gl d l t l by d m c t m
f ma en i m t um th arly p l f r t ph A b sal b d f m
the br n h d basal p t of Gl a d I X 9

(Fig 15 seq) The opposite side gives little evidence of oncoming menstruation beyond the great congestion of blood in the vessels and the absence of secretory activity. The intervening region is transitional.

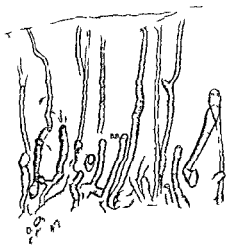
This specimen illustrates that menstrual denudation may occur by sequestration as well as by the gradual crumbling of the superficial zone as illustrated in the two preceding

specimens. It further shows that different areas of the same mucous membrane may at the same time present different stages of the menstrual process.

CC 101 second day. The mucous membrane is 0.6 to 2.8 millimeters thick. This is due to the fact that in the depth of the fundus the mucous membrane is still intact (Fig 16). Here we see a hemorrhagic stratum compactum containing numerous decidual cells and traversed by the slender necks of the glands. The gland necks expand suddenly into flat



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pha Th tr m mor d se tha th ly ph e
and th gl d pp r m e n mer u X 9



F 5 CC 4 5 ft th d y Lat p o l i t pha
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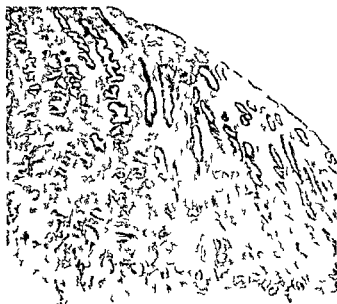


Fig 6 CC 16 twenty first day Photomicrograph of a 6μ section of a mucous membrane in the early pregravid phase. A stroma of organized connective tissue, increased width of the gland, and increased mitotic activity characterize this stage. $\times 20$

tended much convoluted ribbons as the spongiosa is reached. We find all transitions from this condition to almost complete desquamation of the functional layer. This specimen also illustrates the necessity of making a complete survey of a menstruating endometrium rather than of studying a single block.

CC 93 second day. The mucous membrane is 0.5 to 1.0 millimeter thick. There is little or no evidence of secretory activity in the remaining portions of the glands, and the gland lumina contain a scanty secretion and a few blood corpuscles. Occasional patches of epithelium in the late stage of secretory activity may be observed. There is abundant blood in the superficial area, and lymphocytes are numerous. No mitoses were observed.

In the fundus the glands are simple cylinders which divide as the lamina basalis is reached. Here there are isolated gland tubules near the tunica muscularis which we interpret as basal buds. Free glands may project for a considerable distance above the surface into the lumen of the uterus. In the region shown in Figure 17 part of the functional layer persists as is shown by the irregular form of the glands.

Repair. With the beginning of re-epithelization the postmenstrual repair stage starts.

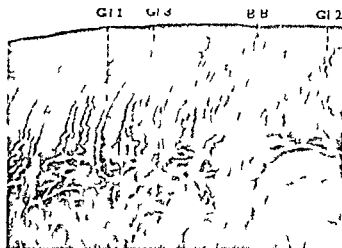


Fig 7 CC 61 twenty third day. Photograph of a thick free hand section of a mucous membrane in the early pregravid phase. Beginning smoothness and alveolation in the base of the gland is observed. $\times 15$

CC 161 fourth day. The mucous membrane is 0.5 to 0.8 millimeter thick. Histologically the lamina basalis, which is all that remains of the mucous membrane, is normal (Fig 18). Slight evidence of blood extravasation remains, and there is no lymphocytic or plasma cell infiltration. Many glands extend above the surface and occasionally they are bent over in contact with the adjacent stroma. In a few regions epithelization seems to have begun by the migration of epithelial cells from the mouths of the glands (Cf 15) and in one instance a layer of surface epithelium connects the mouths of two glands, proof of beginning epithelization.



Fig 8 CC 66 twenty first day. Photograph of a free hand section of an early pregravid mucous membrane in which the spiral type of gland is common. $\times 15$



I o CC 98 th ty na d vs ft the b g n f
th l t p d A ty f p gra d gla d l t d
f m th muc m mb f a p t t h m n tr u l
l tory gul Gland b l bud dil t d w th
t Gl d 2 is bbon h k type Gland 3 a

I d l htly m difed typ w th ru se all Gl d 4
xtr m typ f preg d tr f mat X
F CC 298 th ty days aft th bec g f
th l t peri d A rbb n l ke gla d ph t g ph d f m
t d s Comp 15th Gla d F re 9 X 20

The decidual gland If an ovum is implanted in the endometrium menstruation does not interrupt the process of pregravid change secretory activity continues in the gland epithelium stroma changes are accelerated in a striking fashion the stroma cells hypertrophying into the larger decidual cells and consequently the compact and spongy layers are more clearly differentiated. There are no sharp differences between the pregravid mucous membrane and the early decidua the pronounced decidual reaction for example is the only criterion by which a three week decidua in our collection may be considered more advanced than one of our non gravid 26 day specimens.

H 518 (estimated at 18 to 19 days by J P Greenhill 197) The decidua is 3.9 millimeters in thickness. Only an occasional gland is actively secreting the remainder of the epithelium is in a resting stage. This is probably due to conditions which brought about the abortion. Numerous blood sinuses and a few areas of extravasated blood appear in the superficial portion of the mucous membrane. A division into compact and spongy strata can be observed.

The glands are sparse and frequently slender with ridge like alveolations of the gland

walls which produce localized increase in their diameter. Not all of the alveolations are symmetrical they may appear as irregular ridges upon one surface. Since these are more common than the symmetrical alveoli sections through the glands have a markedly irregular appearance. They do not present the typical saw toothed condition in longitudinal section.

H 951 This specimen is a 3-4 weeks pregnancy with a 4.0 millimeter embryo. The decidua is 6.8 to 11.6 millimeters thick. The surface of the decidua vera is dissected by irregular furrows. In the stratum compactum the glands appear as straight slender tubules .03 millimeter in diameter the epithelium of which is flattened and appears stretched. In the stratum spongiosum the glands widen suddenly and closely approximate each other. Their epithelium is in an advanced stage of secretory activity. The outer wall of the glands in the stratum spongiosum are frequently smooth except for narrow irregular invaginations of stroma elements which form the cores of the saw teeth usually. Since other irregularities do not usually appear upon the surfaces of the gland it may be assumed that these were eliminated by the expansion and mutual compression of the gland.

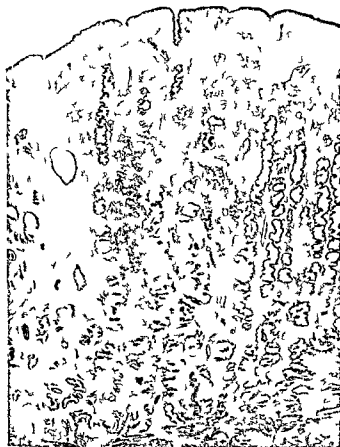


FIG. 11. CC 143 twenty third day. Photograph of a 10μ section from a late pregravid mucous membrane. Very few mitoses and the beginning of the late stage of secretory activity and beginning division into a stratum compactum and spongiosum characterized this mucous membrane $\times 20$.



FIG. 12. CC 143 twenty third day. A group of glands drawn from a thick free hand section of the same endometrium as shown in Figure 11. Note the sinuous alveolated shape and slender necks opening into the uterine lumen $\times 19$.

It presents a stage intermediate between Grosser's (1925) figures 119 and 121.

H 465. This specimen is classified as approximately six and one half weeks of age. The embryo measures 160 millimeters in crown rump length. The decidua is 48 to 90 millimeters thick. Both histological and thick sections show a resemblance between this specimen and H 951 described above. It unquestionably represents a more advanced stage. The stratum compactum now forming one half of the entire thickness of the mucous membrane is much wider and the necks of the glands which traverse it correspondingly more slender. The epithelium of the surface and of the necks is low and atrophied. The decidua lacks a well defined lamina basalis.

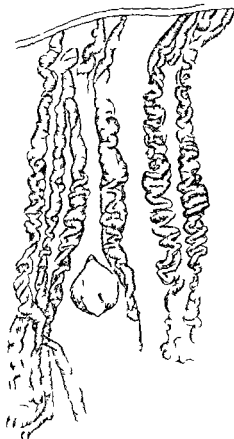
DISCUSSION

The stage of repair consists in the epithelialization of the wound surface by the conjunc-

tion of epithelial sheets which migrate from the mouths of the glands. As a result of the gradually increasing mitotic activity the slender simple glands of the period of proliferation are reconstituted.

Throughout the proliferative period the glands lengthen and the lumina widen. The rate of growth of the glands becomes more and more rapid as compared to the stroma and as a result the gland assumes a sinuous form. With the onset of secretory activity the individual gland cells increase in size adding still more to the gland surface.

During this time the number of glands may be increased by the growth of basal buds from the lamina basalis to the surface. It is possible that some of the basal buds may represent the remains of glands which did not join in the epithelialization during repair period and so did not reach the surface; the majority take their origin from the bases of the glands.



I 3 CC 60 th t th j y C p f gla d dra
f m tl k fr ha d t f mu s m mb n that
had a h d th h ight of the p g d ph $\times 9$

Since basal buds are to be observed in practically all specimens of the proliferative stage we are justified in believing that the number of glands is normally increased during the cycle. A comparison of photomicrographs of the eleventh and twenty-third day cases (Figs 1 and 11) makes this appear to be the case. This is however a difficult matter to decide. If we were to assume that the stroma remains stationary during the cycle it would be easy to show that the decrease in distance between the glands is simply a matter of their increase in diameter but this assumption is false because we know that the uterine mucous membrane doubles or triples in thickness during the pregravid period as compared to the period of repair and thus involves a material increase in the stroma. The stroma cells are separated by an accumulation of oedema



F 4 CC Th k f ha d t n f m th
first day f m n tru t n Th m o m mbra e h d
nd g m k l pr g it n f m t The trom
h f sen d t ng l th bl od th gl d a
f l t t nd p j t l th d s f th n c t
str m $\times 9$

fluid. In order to prove then that the number of uterine glands increases during the cycle it would be necessary to determine the ratio between the stroma growth and increase in glandular surface. This could be done only by studying the statistics of many hundred of normal cases. The alternative would be to count every gland in a large series of normal uteri with similar histone removed early and late in the cycle.

The gradual cessation of proliferative activity during the latter half of the cycle leaves some of the basal buds which may be very numerous (CC 141 Fig 5) stranded at a variable distance between the lamina basalis and the surface. When pronounced secretory activity is inaugurated in the gland the buds which have not reached the surface are dilated for the only path by which the secretion could reach the lumen of the uterus is by way of gland tubules in the



Fig 15 CC 83 Photograph of a block of tissue in alcohol from the first day of menstruation. The mucous membrane shows different stages of the process. SIQ indicates an area in which sequestration is occurring. The opposite area is hyperemic while the transitional area is hyperemic and necrotic. Evidently it will next be affected by the menstrual process. $\times 15$

lamina basalis. The peripheral dilatation of such basal buds shows that secretion does not follow such a course.

The uterine glands differ from most other glands of the body in their periodic intense proliferative activity, their separation from

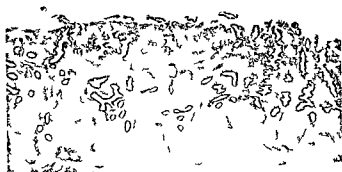


Fig 17 CC 93 A photomicrograph of an 8μ section from the second day of menstruation. Little remains besides the somewhat sinuous and alveolated basal portion of the glands in a zone of the functional layer overlying the lamina basalis. $\times 20$



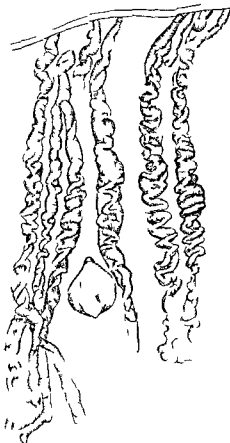
Fig 16 CC 101 Photograph of a thick fragment of endometrium from the second day of menstruation. An area of intact mucous membrane is shown which grades off to a most complicated necrotic illustration that necrotic changes do not proceed at the same rate throughout the endometrium. $\times 10$

each other by an abundant stroma, their very delicate connective tissue sheath and their periods of heightened secretory activity. The combination of these factors naturally results in irregularities in the form of the glands, budding from the gland walls, union of buds from adjacent glands in the basal zone and branching.

In their pregravid transmutation the changes which the glands undergo are purely fortuitous, being a combination of the circumstances of torsion, degree of secretory

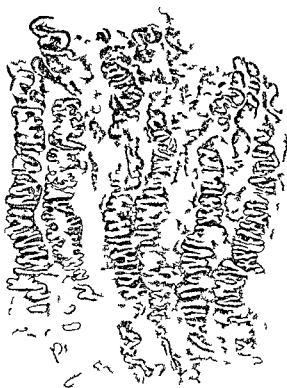


Fig 18 CC 161 fourth day. The stage of repair. Only the lamina basalis remains. At the epithelial cells are migrating from the mouth of a gland to resurface the mucous membrane. $\times 20$



I 3 CC 3 tl t th d y G I f l d dr n
f m th kf h d t f m u m ml a th t
lad r l d th h i l t f th pr d pl X 9

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I 4 CC Th kf h d t n f m th
f r s t d y f n n t r u t n Th m u m m b r h d
u l g o m k e l p g i t n f m t Th t o m
f l n d a d g d th b l o d th g l d
f h y t t n l p j t b th d s f h e n c o c
t m X 9

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SUMMARY

During the period of proliferation the uterine gland is characterized by its slender cylindrical shape with a lumen less than one half the diameter of the gland. Usually the lumen is somewhat greater basally but even at this stage irregularities are encountered.

The simple tubular glands may end in slight dilatations at the base of the mucous membrane, or they may divide at any point in their course but this is uncommon except in the lamina basalis. Rarely we see two glands unite and the single trunk extend to the tunica muscularis. In the basal zone branches of the second or third order may be found and they may follow a course parallel to the muscle layer. These ultimate branches are slender tubes sometimes of considerable length. In this proliferative stage basal buds are observed appearing first in the basal portion of the functional layer and projecting toward the surface. The later the stage in the cycle the longer the buds usually are.

As growth progresses increase in width of the glands occurs. bifurcated glands are more common and undulations or symmetrical alveolations appear first in the basal part of the functional layer and gradually extend throughout the glands. Further changes are fortuitous and the final shape assumed by the pregravid gland is variable depending upon secretory activity and differences in growth between the stroma and gland epithelium. These glands may be circular or oval in cross section and follow a spiral or undulated course with occasional buckling of adjacent limbs upon one another at different angles. In many mucous membranes an undulated ribbon like gland predominates. A few glands even in the most pronounced pregravid mucous membranes remain slender and unchanged save for a slight rugosity of their walls. The tubules of the lamina basalis usually remain unchanged.

During the necrosis accompanying menstruation the glands are more resistant to this necrotic process than is the stroma and as the necrosis progresses the glands can always be observed protruding above the level of the stroma.

In repair epithelization occurs by migration of the epithelial cells from the mouths of the glands and this process is aided by the tendency of the projecting glands to bend over upon the denuded surface. Mitotic activity begins at once immediately crossing changes in the mucous membrane.

The typical decidual gland is characterized by two features: (1) a long slender neck traversing the stratum compactum and (2) an almost smooth exterior in the stratum spongiosum which has resulted from pressure and dilatation. The original irregularities persist as projections into the lumen.

Acknowledgment: due Dr Geo W. Bartelmez under whose supervision the present problem has been under taken for many of the illustrations included for criticism in revision of manuscript and for constant encouragement. We are also indebted to Miss Agnes Nixon for the drawings which accompany the text and to Miss C. M. Bensley for aid in the preparation of material.

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TABLE I—CLINICAL DATA ON THE SPECIMENS DESCRIBED

LC N	D y l	L g b l d f f w	A m b e f p f p g	D y m f m	P tholo- t d gnos	Spe d d
8 p f f i		8 3	7 p	9 m	l b b m y m b i t f i	C p f f
58 (f)		8 4	9	mos	Pyo- l i g	F d
(p f f i)	5	8/ 3	p	6 m	F b	Wh l
6 (t g r)			p	k	P l p e t	Wh l
66 (g)		8 5	p	7 k	P l p e t t	F d
8 p l		8 5	p	10 set	F b os l	C p f d
pc g l	5	?	f	6 k	P l p e t	Wh l
(p)	3	8	5 p		F b t	Wh l
(m)		8			P l p	C p f d
7 (m f)		3	p		I b d	C p f d
5 m)		8	5 p	m	I b d	Wh l
3 m		8 7	?	ks	F b m y m l	t f d
(m ns)		/	42 p	y	P l f t	Wh l
6 (m)			f		I b d	t p f d
H 5 8 l l	d d k	?	f	?	Ab	F t d
H d)	7 l k	?	f		F b m m	Wh l
H (ec)	?		?	??	I l m m	Wh l

activity differences in the rate of growth between epithelial and stroma elements and pattern of the investing blood capillaries the *e* factors may vary in their effect and as a result the eventual form of the gland varies. Symmetrical spiral gland such as have frequently been described from study of thin sections are rather uncommon in our material.

In Figures 11 and 13 taken from pre-gravid mucous membranes there are suggestions of slender necks interposed between the convoluted portion of the gland and the surface and traversing the compact layer. These slender necks are the forerunners of the elongated necks of the decidual glands which are lengthened after the implantation of the ovum as a result of the hypertrophy

of the decidual cells in the development of the stratum compactum. Such a process of hypertrophy increases the thickness of the compacta and so the epithelium of the gland adjoining the surface is stretched out and the diameter of the lumen decreased.

Secretory activity is accelerated in the decidual gland and as the outlet is perhaps restricted secretion accumulates to a greater extent than before. The gland comes into contact with one another and the external irregularities are more or less smoothed out by mutual pressure. The original folding of the wall nevertheless persists as a projection projecting into the lumen. Thus we have the saw-tooth pregnancy gland to which Opitz called attention in 1899.

CLINICAL SURGERY

FROM THE DIVISION OF NEUROLOGICAL SURGERY UNIVERSITY OF CALIFORNIA

BRAIN SURGERY

WITH SPECIAL REFERENCE TO EXPOSURE OF THE BRAIN STEM AND POSTERIOR FOSSA THE PRINCIPLE OF INTRACRANIAL DECOMPRESSION AND THE RELIEF OF IMPACTIONS IN THE POSTERIOR FOSSA

By HOWARD C. NAFFZIG, M.D., I.A.C.S., SAN FRANCISCO
Fifth Edition 1958 by J. C. H. M. I. H. I.

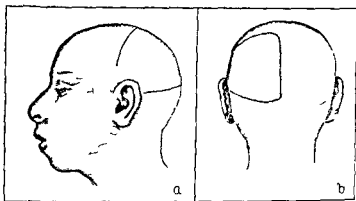
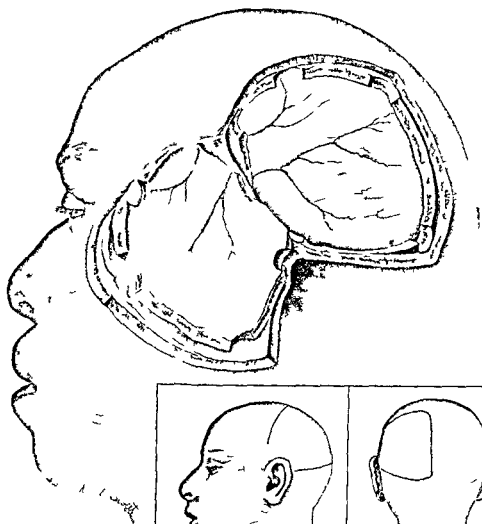
THE fascination of brain surgery lies in its difficulties. More than in the surgery of other parts the mere opening and closure of a wound is a major procedure. It involves a difficult approach through exceptionally heavy and resistant structures to organs vital, delicate and readily traumatized. It is laborious, time-consuming, detailed work with constant possibilities for hemorrhage. The surgical treatment of the lesion itself often involves less time and effort than the exposure of it and the closure of the wound. The vascularity of the coverings and the special technical methods required to open the skull without injury to its contents both present their problems and their risks. For the future of the patient proper closure is of the highest importance. On the surgeon it makes special demands. The slow, painstaking, detailed closure at the conclusion of a trying operation demands a self-exacting thoroughness not often called upon in other situations. More rapid but less detailed methods of repair bring in their train late hemorrhage, herniations, brain damage, fungi and hideous harmful protrusions and scars. Training in this branch of surgery necessitates a degree of gentleness and attention to detail seldom acquired in the surgery of less delicate structures. Special methods are demanded for the control of bleeding and much experience in avoiding it. The elaboration of the technique of neurological surgery is evidence of the necessities, though simplification of technique is always desirable.

Since the days of Lister the osteoplastic bone flap of Wagner with its wide exposure has replaced the measurements of cranial topography and the selection of a much debated localizing point for a trephine opening. Likewise craniectomies have given way to plastic operations upon the skull except in the subtemporal and sub-

occipital regions. In these areas where other structures than bone may give adequate protection to the brain such openings have their especial decompressive advantages. The temporal and cervical muscles act as protective coverings and at the same time restrain excessive or harmful herniations. Brain herniation through properly placed decompressions will cause no disabling symptoms. Operative procedures tend to become standardized. While for decompressions and approaches to near by structures these craniectomies have especial advantages the plastic operations are generally used for the cranial vault.

For operations upon the hemispheres—the parietal, frontoparietal and frontal osteoplastic flaps are used. All have their bases in the temporal region. With the thin squamous portion of the temporal bone in this location they break back readily. The temporal muscle and fascia act as a hinge. With the flap reflected removal of that portion of the bone beneath the temporal muscle permits leaving a decompressive opening after the flap has been replaced. These large flaps permit of wide exposure. Elevation of the frontal and temporal lobes gives access to the structures of the chiasmal region. The entire anterior fossa and the anterior portions of the middle fossa can be reached.

Less systematic attention has been given to surgical approaches to those structures in front of the cerebellum and between it and the third ventricle. This portion of the brain stem, the pons, tentorium and pineal region has received little notice. The surgery of this area involves special considerations. The principle of decompression to permit expansion outside of the cranial cavity is old. Yet within a certain part of the cranial cavity impactions occur.



Г Th ml d ft ti su db fl p o th p d l Th e l f th du u
f b f b k l

Brain Surg y—H aa d C Vaff ig r

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Fifth D. N. 15 g. v. L. 13 C. H. M. d. 15 hool

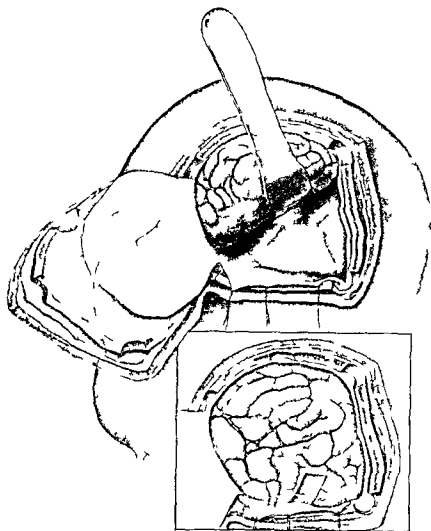
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Γ Th fl p f l tu d d t p d l th l l d pply
p d Th f t l b t d f r d s f m th t t n m

Decompressive craniectomies of the lower portion of the occipital bone do not always relieve the pressure even when due to tumor in the posterior fossa. Persistent blockage of the peripontine pathways may persist. Enlargement of the posterior fossa below by suboccipital craniectomy is often disappointing for this reason.

The subtentorial space may be enlarged by wide opening of the tentorium or by section of the tentorium including the incisura tentorii. The approach is best made from above through what we have termed the occipital flap. The field of usefulness of this operation has widened in that it also serves as a supratentorial approach to certain infratentorial tumors. It permits access

to the pons to all tumors which spring from the tentorium and the posterior half of the falx to the entire occipital lobe and all the midline structures. Ready exposure of the upper and anterior surfaces of the cerebellum is made in areas which cannot be uncovered by a suboccipital operation. Enlargement of the posterior fossa gives added opportunity for expansion upward. The brain stem is no longer crowded down into the foramen magnum. Expansion upward even of large masses beneath the occipital lobes gives no symptoms and the blockage of peripontine fluid pathways with hydrocephalus is relieved. Impaction of the brain at the incisura often demands unusual methods to procure relief from pressure.

PREPARATION OF THE FIELD OF OPERATION

Shaving of the scalp is invariably performed on the morning of operation. Earlier shaving particularly if not carefully done may cause irritation or slight scratches may form ideal nesting places for staphylococci. Careful shaving is an important step in the mechanical cleaning of the scalp. When combined with equally detailed scrubbing with soap water and alcohol the use of other antiseptics can be left to the whim of the operator. Careless and rough scrubbing causing minute abrasions of the scalp is to be avoided.

ANÆSTHETICS

In this country while ether is the most favored anæsthetic local anæsthetics are being used more and more in the surgery of the central nervous system. In our experience ether has been highly satisfactory. Long periods of anæsthesia are common. It is our impression that when properly administered little difficulty can be justly laid to the ether anæsthesia. It is noteworthy that postoperative pneumonias are more rare after it in neurosurgical cases than in other types of surgery as reported by Cutler and Hunt (1) from the Peter Bent Brigham Hospital and by Terry (2) from University of California Hospital. It is our impression that children stand long periods of ether less well than adults. Even in the longest operations on adults other more likely causes could always be found if the condition of the patient was poor. Cranial operations are in many ways well adapted to the use of local anæsthetics. Only the structures external to the skull need to be anesthetized. While the sound and feeling of the work on bone is unpleasant and may be startling when bone is fractured it is not painful. Likewise ordinary handling and cutting of the dura is without sensation. The brain is of course insensitive.

Bleeding is lessened by the injection of a local anæsthetic with or without adrenalin as contrasted with the fact that there is apt to be increased congestion with ether. Wound healing in our experience has been equally good with both. It is not an uncommon experience to find that advocates of local anæsthesia use considerable amounts of drugs having general effects particularly morphine and scopolamine. This is hardly local anæsthesia and certainly such drugs in individuals prone to respiratory difficulties from pressure should be used guardedly if at all. In our own experience $\frac{1}{2}$ to 1 per cent novocaine with 3 drops of 1:1000 adrenalin to the ounce has been used for infiltrating the scalp and for the deeper injections between pericranium galea

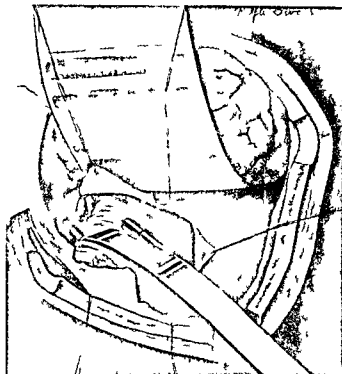


Fig. 3. The cranium is retracted from the base of the brain exposed after the tentorium.

and scalp. Lessened tendency to scalp bleeding occurs but another important factor in lessening bleeding is the use of a position in which the head is higher than the body though not necessarily a sitting position. In the event of respiratory difficulties it is desirable to be able to lower the patient's head.

As to the choice of anæsthetic in an individual case. While judgment changes from time to time it is our custom to consider local anæsthesia preferable in stuporous patients especially in those with respiratory difficulties or very high degrees of pressure and in others who may themselves prefer it. Likewise it is favored in patients with marked cardiorenal disease or pulmonary infections. The mere fact that an operation can be carried through with little or no pain under a local anæsthetic is not to our mind a sufficient reason for invariably insisting upon it. If in such a case the patient is sweating or exhausted and worn out at its conclusion one can hardly feel it is altogether satisfactory. It requires a considerable degree of equanimity and fortitude for a patient unfamiliar with his surroundings to submit to a brain operation under local anæsthesia. In special instances a light general anæsthetic has been used for the latter portions of long operations. For the use of ether the intrapharyngeal method has met all requirements.

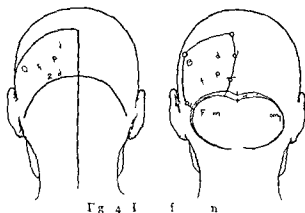


Fig. 4 Fig. 5

THE GENERAL TECHNIQUE OF OSTEOPLASTIC FLAPS

Selection of the site of incision taking into account the area to be explored and leaving an adequate pedicle for the flap circulation and marking of the site should precede a firm draping of the field. Cross hatching of the line of proposed incision will facilitate proper matching of the margins upon closure. Digital pressure of assistants on each side of the incision is used to control bleeding and retract the margins of the wound while straight fine pointed hemostats are applied to the fibrous under layer of the scalp at frequent intervals usually about 1 centimeters. As these clamps are laid back the vessels of the scalp though they may not be included in the bite of the clamp are compressed. The scalp of the flap itself may be controlled in the same way or its base may be constricted by means of a special clamp.

For primary bone openings a broad perforator the point of which will pass through to the dura while the broad portion is still engaged is safe.

If the operator is careful to test bone thickness by percussion he will avoid possible accidents when dealing with the paper thin areas occasionally met. In placing the perforator openings it will be found that it is desirable to have the base of the bone flap near its hinge narrower than the free margin. If the two perforator openings near the base are placed to keep this in mind the flap when replaced will lie in position more satisfactorily. Five perforator openings in all are usually sufficient. The perforator openings may be enlarged with a burr of the same size. Motor driven instruments are preferred by some but add greatly to the armamentarium and to sterilization none to the safety and save but little time. With properly sharpened instruments the effort of making the opening is slight. Larger burrs are required to bevel the openings properly when the bone is unusually thick. Narrow long curved

periosteal separators are used to separate the dura from the bone prior to passage of guides for Gigli saws. With them the dura should be freed for the entire distance between openings. Two thin ribbon guides of spring steel with blunt points may be passed between adjacent openings. To a hook on one of these next the bone the Gigli saw is attached and drawn through. The second guide lies against the dura and protects it from the saw. With the Gigli saw the bone is cut from within out and beveled outward. It is well not to incise the galea and pericranium deliberately prior to this stage as if done it will be found that venous oozing from bone will occur and there is also a greater tendency for the soft tissues to strip from the bone of the flap. It is desirable to use fairly fine rather than coarse saws for though the latter cut faster they permit the flap to settle unduly when it is replaced. The base of the flap may be fractured back but when the bone is heavy as in the occipital flap it may require special cutting with saw or bone cutting forceps. Bleeding from the bone is controlled by the use of bone wax.

Pfection of the bone flap may reveal bleeding bone marrows or bleeding from dural vessels. Temporary control of the latter by small wet cotton sponges and pressure will usually permit of the opening of the dura when they can be more safely controlled by suture or the use of wire clips. Prior to the opening of the dura the reduction of intracranial pressure is often necessary to prevent sudden herniation and brain contusion. This is readily accomplished in the presence of a hydrocephalus by ventricular puncture. Even in its absence some fluid may be obtained by ventricular puncture or hypertonic intravenous solutions of glucose or 1 in 400 solution may be used. Occasionally puncture of the opposite ventricle through a separate opening is necessary. In our experience the dura is best opened by a flap incision with the base of the flap toward the longitudinal sinus. This permits of easier closure in the face of considerable pressure. The site and character of the lesion with which we are dealing often make some other arrangement of the flap advisable.

For the control of cortical vessel about a tumor ties with fine silk and silver clips are useful. Hemostats cannot be used and it is passed beneath the vessel with a blunt fine curved needle. During intracranial work and especially in surgery of the brain itself irrigation with Ringer's solution at 40 degrees C. largely replaces sponging and serves to keep exposed surfaces from drying. Moist cotton material

for small pressure packs. No gauze or other rough contact is permitted. Suction apparatus to withdraw fluid from cavities and largely to replace pouncing may be used with satisfaction. Small dural vessels may be controlled in the same manner or plastered with bits of muscle when tying or clipping is not feasible. For closure we believe that except over the area of a purposeful decompression the dura should be closed. Areas of dural defect in the absence of cause for pressure may however be permitted in certain instances. In the presence of pressure dural defects or dural and bone defects should not be left over the cerebral hemispheres except perhaps in a few instances of inoperable tumor already causing complete loss of function of that part of the brain.

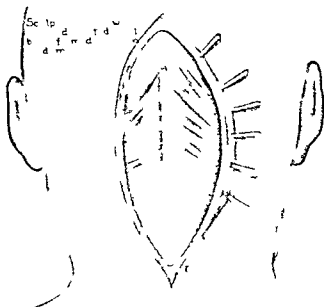
For dural closure as for closure of the deep scalp and in trials of many materials and many types of sutures have caused a return to the fine silk suture. Closely spaced sutures in the deep layer of the scalp best control bleeding. Ties of scalp vessels are rarely necessary and when used a suture is whipped about the vessel and then tied.

THE OCCIPITAL FLAP

The following procedure was first used in 1911 to gain access to an acoustic neuroma which had been found at an earlier suboccipital operation to be too high in the angle for a satisfactory approach by that route. Since that time this operation has been used with increasing satisfaction for a wide variety of lesions.

The occipital flap provides a supratentorial approach to infratentorial lesions. With tumors and with impactions in the posterior fossa it offers a method of intracranial decompression.

The occipital flap is placed with the hinge just above the mastoid and the posterior part of the temporal fossa. The anterior margin of the flap extends from the posterior part of the temporal fossa upward to the region of the longitudinal sinus and usually in front of the parietal eminence. The posterior margin is parallel to and immediately above the lateral sinus. The mesial margin of the flap is parallel to the longitudinal sinus and close to it. The patient is placed in the face down, cerebellar position, the flap fashioned in the usual manner except that the hinge of the flap should be sawed as are the other margins. The thickness of the bone at the hinge is great enough to make the fracturing of it difficult and uncertain. With the dura exposed ventricular puncture is performed and the ventricles well emptied. Nearly all of the lesions for which this operation is performed are associated with an internal hydrocephalus. The



F. J.

emptying of the ventricle permits of easy elevation of the occipital lobe and wide exposure (Fig. 3).

The dura is opened usually with the hinge anteriorly. A varying number of veins will be found communicating with the lateral sinus from the margin of the occipital lobe. These are clipped or tied and divided. From the dura over the petrous bone in the region of the internal ear two or three veins from the temporal lobe may likewise need ligating. The occipital lobe if the ventricles are well emptied is then elevated with a broad flat spatula or broad lighted retractor. The lifting of the occipital lobe upward exposes the tentorium, the attachment to the margin of the petrous bone, the floor of the middle fossa and far forward to the posterior clinoids. Retraction of the lobe laterally from the falx exposes all the posterior portion of the falx, the entire half of the tentorium and up to the corpus callosum, the pineal region and the incisura tentorii. The sinus rectus, lateral and longitudinal sinuses are of course all visible. No other flaps in ordinary use give as wide a range of exposure as does the occipital flap.

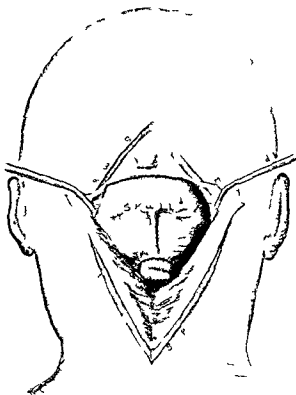


Fig 6

For approach to the infratentorial lesions if pressure in the posterior fossa is high even after the reduction of supratentorial pressure by the ventricular puncture a lumbar puncture may be performed.

Incision is made in the tentorium. Occasionally irregular venous sinuses may be seen in the tentorium but can be controlled. The incision in the tentorium is widened in all directions up to the petrous bone anteriorly to the sinus rectus mesially and to the lateral sinus. An occasional vein bridges between tentorium and cerebellum and requires clipping. With this opening the upper surface of the cerebellar lobe is exposed over a wide area (Fig 3). Etraction of it backward and laterally gives an exposure of the angle and the pons. The seventh and eighth nerves are seen below and the fifth root toward the midline. Beneath the apex of the tent may be seen the opposite cerebellar lobe.

In the use of this method less dislocation of the cerebellar hemispheres and brain stem is required to secure a high approach to the angle. The pons may be seen and dissection conducted away from it rather than toward it as is the case from a crossbow incision.

With invading tumors the large tentorial opening which is not closed permits an intracranial decompression of the posterior fossa with relief of the impaction so often seen. Following a suboccipital operation for an irremovable tumor the internal hydrocephalus and increased pressure may persist due to unrelieved block. In such instances the tumor together with the other structures of the posterior fossa so fill the space that an impaction persists. Blockade of the fluid channels about the incisura tentorii—the peripontine pathway and the midsagittal cerebellar channel or the posterior part of the intraventricular system persists. Wide opening of the tentorium permits upward expansion of tumors which otherwise press the cerebellum downward and enlarges the subtentorial space. Protrusion or extension upward beneath the occipital lobe is accompanied by no symptoms and great expansion is permitted. With great dislocation of structures in the posterior fossa the incisura tentorii may be cut.

This has resulted in the relief of obstructive hydrocephalus when suboccipital decompressions have failed. At the conclusion of the operation the dura of the tentorium is left widely open. The dura over the vault is completely closed and the flap replaced.

MODIFICATIONS OF METHOD

In individuals who have previously been subjected to a suboccipital operation the occipital flap may be modified. If there has been a suboccipital crossbow incision one lateral half of the incision may be used to form the posterior margin of the occipital flap (Fig 4). In such instances the scalp has been dissected downward sufficiently to expose the line of previous incision in the neck muscles just below the superior curved line. The muscles have been cut again along the line of previous incision. The occipital flap has been then formed to include all the bone down to the decompressed area. This involves removal of the bone overlying the lateral sinus but this has proved to be surprisingly free from difficulty. The bone cuts are made in such a way that the flap cannot slide downward due to pull of the neck muscles after closure. In certain instances to secure even greater freedom of exposure the lateral sinus may be tied and divided. The cut may be carried on to the incisura and the entire tentorium reflected. Inasmuch as the suboccipital operation has been previously performed the cerebellum is already decompressed and can be retracted posteriorly and downward much more readily.

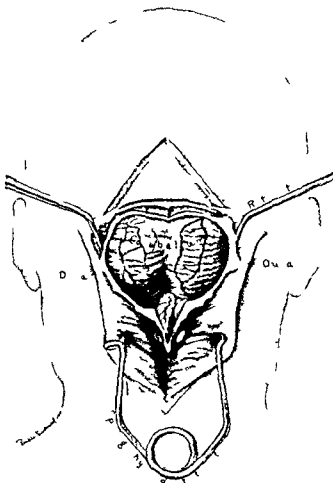


FIG 7

MODIFICATIONS OF SUBOCCIPITAL PROCEDURES

The crossbow incision of Cushing may with certain lesions and depending upon the build of the individual patient be modified to advantage. In the midline tumors of children in intra cerebellar tumors and especially in those adults with long necks a midline incision has been used. In the presence of intracranial pressure the bleeding is lessened during the operative performance by an early reduction of pressure. With an internal hydrocephalus early ventricular puncture through a separate small opening over the posterior horn of one lateral ventricle is helpful. This should be performed at the beginning of the operation. Pressure is at once reduced bleeding lessened and the presence of an internal hydrocephalus confirmed—the absence of which would indicate a probable diagnostic error and unnecessary suboccipital operation. Certain technical points should be observed to obtain the best exposure. The midline incision should extend from about 4 centimeters above the external occipital protuberance downward to the fifth



FIG 8

cervical spine or lower and is carried through the scalp down to the deep fascia (Fig 5). Wide dissection of this layer from the deep fascia is important and the separation is carried well lateralward. The midline between the cervical muscles is split retracted and subperiosteal separation of muscles from the occipital bone is made. This is facilitated by the use of double angled elevating retractors. The subperiosteal separation is carried from the muscle attachment at the superior curved line above to the mastoid laterally and temporary gauze packs introduced. After a similar separation on the opposite side the area of exposure is increased by cutting the deep fascia and muscular attachments to the right and left of the forcula for a distance of about 3 to 4 centimeters. A fringe of deep fascia and muscle is left for subsequent suture (Fig 6). Contrary to the crossbow incision in which the occipital artery and great occipital nerves are divided these structures can be spared. The nicking of the firm ligamentous attachments to the foramen magnum and the atlas and the use of spring thyroid retractors give a wide exposure and permit the same bone removal dural opening and opportunity for decompression and the necessary intracranial work as the wider cross

bow incision (Fig 7) Closure of course is much simplified

THE APPROACH TO TUMORS OF THE CEREBELLO PONTILE ANGLE BY THE SUBOCCIPITAL ROUTE

With angle tumors if approached from below a combination of the above midline incision with a single half of the crossbow incision shortens the procedure considerably without sacrificing the advantages of the full crossbow (Fig 8) The side opposite the lesion can be fully decompressed without wide incision of scalp and muscles On the side of the lesion the curved incision should be carried out to the mastoid and down to or just below its tip To obtain the full advantages of exposure the scalp must be freely dissected well back from the deep fascia before cutting the muscular attachments at the curved line The bone removal must extend fully to the lateral sinus above and laterally to and often into the mastoid cells The bone removal below is carried well beneath the reflected muscles which are thoroughly retracted

In the crossbow operation of Cushing proper handling during and after operation may give rise to two difficulties Impairment of circulation of the angles of the flaps is caused first by too free use of hæmostats in the region throughout the operation and second by deep sutures of the scalp which include and constrict too much tissue and skin sutures which bear the same criticism During the closure for a distance of 2 centimeters from the angles fine skin sutures which take very small bite of the skin only without subcutaneous tissue are sufficient to ob-

tain accurate approximation The full crossbow incision divides the entire occipital nerve supply leaving the most prominent portion of the occiput anaesthetic The risk of decubitus if the weight of the head is allowed to rest indefinitely on this area is obvious particularly since its blood supply is somewhat lessened by the same incision The proper filling up of the suboccipital hollow with an adequate amount of dressings will remove the possibility of too localized pressure and the unnecessary decubitus

As in the surgery of other regions a satisfactory exposure of the lesion is essential For many of the lesions in the posterior fossa the crossbow incision of Cushing or some of the implications of it are satisfactory For the approach to lesions high in the angle it leaves much to be desired The methods here presented have been found helpful By means of the occipital flap a transtentorial approach can be made It affords access to the upper and anterior surfaces of the cerebellum to the fifth nerve and other nerves of the angle This is an ideal approach for lesions of the tentorium the posterior half of the falx cerebri the occipital lobe the pons and pineal region Section of the tentorium and incisure tentorii affords a method of intracranial decompression By means of it hydrocephalus from impaction in the posterior fossa has been relieved when other measures have failed

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FROM THE SURGICAL SERVICE OF RUDOLF HOSPITAL OF VIENNA I

THE THORACOPLASTIC TREATMENT OF PULMONARY TUBERCULOSIS

BY PROFESSOR WOLFGANG DENK, VIENNA, AUSTRIA

D i f f e r e n t i a l S u r g e r y R e v i e w p a t r

THE operative treatment of pulmonary tuberculosis not only is of advantage to the individual but possesses great hygienic importance for society because in the great majority of cases it is possible to free the sputum of the patient from bacilli and this eradicates one more source of infection in the patient's environment. The surgical treatment of pulmonary tuberculosis is therefore of no little importance and deserves to become better known.

If the outcome of operation is to be good the indication for operation must be right. This however is a problem as difficult to solve as it is important. In principle only unilateral cases are suitable for surgical treatment; if internal measures have proved fruitless or the financial status of the patient makes protracted conservative treatment impossible. Old stationary individual foci in the healthy lung form no absolute contra-indication but one must make sure that such foci have no tendency to progression. In addition the diseased lung must disclose a tendency to shrinkage (purely or predominantly productive or proliferative type of tuberculosis). Essentially exudative forms which lead to rapid progression of the disease and cachexia are much less suitable for surgical treatment since the chances for cure or considerable improvement are small and the mortality is great. The one other requirement for operation is the presence of pleural adhesions since the presence of a normal pleural cavity demands the trial of an artificial pneumothorax. It is important to try such a pneumothorax before deciding upon operation. I have repeatedly observed that pneumothorax is still possible in cases in which the pleural cavity is apparently entirely destroyed. Only in exceptional cases should primary thoracoplasty be tried with the presence of a free pleural cavity. Aside from an extensive affection of the other lung, absolute contra-indications to thoracoplastic treatment are high fever, rapid progression of the case, lobar tuberculous pneumonia, decompensated cardiac affection, tuberculosis of the intestines and kidneys and multiple foci of the bones.

Partial thoracoplasty is indicated in cases of incomplete pneumothorax or as a complement to the non collapsed part of the lung in the presence of a lung plug.

Of the various methods of operation in use I wish to discuss only that of thoracoplasty.

TECHNIQUE

Preparation of the patient. Every protracted case of pulmonary tuberculosis damages the heart because of toxic action and the result is to be observed in tachycardia and an easily compressible pulse. Since thoracoplasty calls for reliable heart action because of the reduced pulmonary circulation on the side operated upon it is necessary to carry out a preliminary treatment if the heart is not in satisfactory condition. This is done by the administration of digitalis or cardiazol as well as by keeping the patient in bed. It is especially important to cleanse the affected pulmonary focus as well as possible by means of expectorants so that postoperative stasis of secretions and the danger of aspiration may be avoided. The intestine should also be cleansed in order to save the patient the strain of exhausting enemata following the operation. A half hour before operation the patient receives 0.05 to 0.10 gram of morphine and $\frac{1}{2}$ milligram of atropine hypodermically.

The position of the patient on the operating table is of especial importance. Inasmuch as the operation is if possible to be done under local anaesthesia the patient should be placed as comfortably as possible. The back of the table is raised upright and a round pillow is placed in the lumbar region of the patient. In this way the spinal column of the patient is bent toward the healthy side; the affected side is maximally curved, the intercostal spaces broadened and the operation thus considerably simplified. A pillow is also placed under the head of the patient after it has been bent forward. The arm of the healthy side should not be placed on the pillow under the head but is held down since otherwise quite unpleasant paraesthesia occurs (Fig. 1). An assistant extends the arm of the affected side maximally toward the front and downward in order to draw the scapula away from the ribs. A pillow fastened close to the patient's pelvis on the table prevents the patient from slipping down. The patient's feet hang over the edge of the table but they must be well supported by a chair. The assistant who pulls on the arm of the affected side simultane-

ously pre-poses one fist into that axilla in order to prevent the patient from falling over forward.

Anesthesia. A thoracoplastic operation can almost always be done under local anesthesia and only if the patient is very restless and nervous is it necessary to make use of a short and superficial ether narcosis. I consider that a general anesthesia is detrimental and I have never yet had to make use of one in these cases. The method of choice is conduction anesthesia of the intercostal nerves. After the field of operation has been disinfected 10 cubic centimeters of a $\frac{1}{2}$ per cent solution of novocain or of a $\frac{1}{4}$ per cent solution of tutocaine are injected at the lower edge of the rib in question about three fingers breadth lateral to the medial line of the spinal processes. This injection is made on every rib to be resected in addition to which the line of incision is infiltrated in all 3 layers: intracutaneous, subcutaneous and intramuscular.

If the patient is lean intercostal anesthesia by this method is rather easy. If the patient is very muscular or fat it is often impossible to palpate the point of injection on each rib and this is often impossible as far as the more proximal ribs are concerned as they are covered with thick layers of muscle. In such patients it is advisable to use some other method. One first anesthetizes the line of incision layer for layer with the anesthetic. Then each rib is exposed and the anesthetic applied directly. One should not inject more than a total of 150 cubic centimeters of the anesthetic. In 10 or 20 minutes the anesthesia is complete. Should pain occur during the resection it is necessary to apply a few more cubic centimeters of the anesthetic by injection on the upper and lower edges of the rib in order to free the patient from pain. Superficial general narcosis was necessary in only the most exceptional cases.

Incision. Although the operation at one sitting is to be preferred to the thoracoplasty done in two or more sittings the operation is nevertheless seldom possible at one sitting since it is too great an ordeal for an organism damaged to such an extent. Operation at one sitting will therefore be an exception to be carried out only in a very strong afebrile patient whose heart is in absolutely good condition and in whom the tuberculosis has been of the purely productive form with a tendency to shrinkage.

Generally the operation is carried out in two stages. In the first stage the eleventh to the sixth ribs are resected in the second stage the fifth to the first. Resection should begin over the upper ribs only in the event of a tuberculous empyema which comprises the lower lobe of the lung.

Figure 1 demonstrates the incisions for each rib. The lower plastic is begun with an incision at a level with the sixth rib about 3 fingers breadth lateral to the medial line of the spinal processes; the incision drops perpendicularly to the eleventh rib and then about a hand's breadth laterally along the eleventh rib. For the upper plastic the incision begins at about 3 or 4 fingers breadth under the shoulder extends first between the medial spinal line and the medial scapular margin downward as far as the scapular angle and then laterally until just under the latter. The incision should not reach the apex of the shoulder because this would cut muscle tissue unnecessarily and in addition provoke muscular atrophy by severing the branches of the transverse scapular artery. This result is not only disfiguring but also inhibits the function of the arm. An arch like incision around the scapula easily permits the latter to be lifted away from the thorax thus offering a broader approach to the ribs just under it.

The incision should penetrate the skin the subcutaneous tissues and also all the muscles as far as the ribs in the same direction. The soft flap thus formed is pulled away laterally as far as possible from the bones of the thorax. This is of especial importance in the scapular region. The long muscles of the back are separated from the bones and drawn toward the spine thus exposing those portions of the ribs between the costal angles and the lateral spinal processes. It is usually possible to secure hæmostasis in this part by suitable compression. It is very important to treat the long muscles with consideration since they are the foundation of the upright posture of the spinal column and any considerable damage of them will enhance the tendency to scoliosis following thoracoplastic. Now the ribs are free for resection. The periosteum in the middle of the ribs is first split and then with the rasp pushed away toward both edges. In order to expose the anterior surface of the ribs the edges must be absolutely free from periosteum. This is best insured by using the rasp from median line outward on the upper edge and from the side toward the inside on the lower edge (i.e. against the direction of the fibers of the intercostal muscles. Fig. 1). As soon as the posterior surface of the rib has been exposed the detachment of the periosteum from the anterior surface is carried out by means of a curved rasp (Fig. 3).

The effect of the operation is considerably improved if the ribs are extensively resected. The greater the destruction within the lung the greater must be the extent of the resection and the collapse effect. The length of the pieces resected

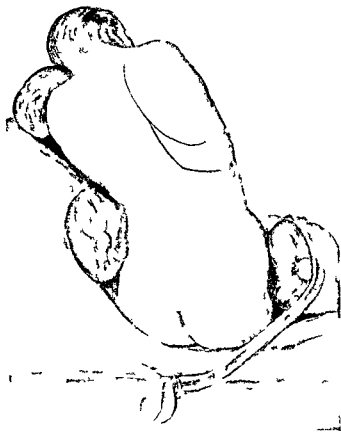


Fig 1 Showing position of the patient on the operating table and incision lines for first (a) and second (b) stages

determines the degree of collapse. In general 10 to 15 centimeters are resected from the lower ribs, 10 to 12 centimeters from the middle ones and 4 to 10 centimeters from the upper ones. In principle the resection should approach the spinal column as closely as possible and it is of particular importance to pay close attention to just this point during resection as one is otherwise surprised at the length of the stumps remaining. If the stumps are too long the collapse effect is usually too small and it is sometimes necessary to reduce the length of the stumps as far as the lateral processes of the spine by means of bone forceps.

The resection of the 5 upper ribs demands individual attention (second stage). Under normal circumstances with the scapula in position these ribs are covered by the scapula. Now the successful collapse of the proximal ribs is of great importance because the upper lobe is usually most deeply affected and it is therefore very necessary that precisely these ribs be extensively resected. In order to make this possible the scapula must be retracted energetically by an assistant by means of 2 retractors (Fig 3) this being possible

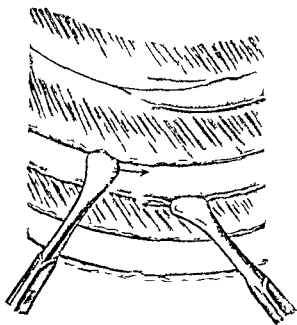


Fig 2 The use of the rasp from the side (right) toward the spine on the lower edge and from the spine to the side (left) for the upper edge to free the rib of periosteum

because of the arch incision mentioned above. In this way it is possible to resect pieces as long as 10 to 12 centimeters even in the upper ribs. The decisions as to whether larger or smaller pieces should be resected depends upon the extent and advance of the pulmonary destruction.

The most difficult part of thoracoplasty is the resection of the first rib. The resection of this rib is absolutely necessary in every case. The approach is made suitably free by firm upward retraction of the soft parts (Fig 3). It is always necessary to take every precaution that the rib considered as the first is really the first; otherwise it is quite possible that the rib can be overlooked. This rib can be recognized by the fact that the surfaces are horizontally placed facing up and down instead of forward and backward. Since the first rib is considerably shorter than the others it is sufficient for our purposes if we resect only 3 to 4 centimeters from it. As it is particularly difficult to resect part of this first rib, special instruments are necessary, the best of these being the rasp and rib scissors recommended by Sauerbruch.

Just above the first rib the brachial plexus and the subclavian artery and vein pass by. In the event that resection is not executed with caution these structures can be damaged with the rasp as well as with the rib shears. Reports of such cases have been published. The injury to the subclavian vein may lead either to fatal hemorrhage or to air embolus and must therefore be avoided under all circumstances. But there are also secondary

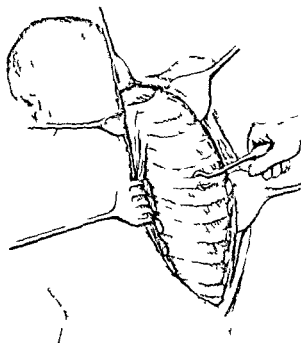


Fig. 3. A. d. p. d. f. n. f. f.
b. f. f. o. t. m.

injuries to these structures such as those due to the presence of sharp edges or ends to the rib stump. It is therefore necessary to smooth these as well as possible by means of the rib forceps.

After the operation has been completed (first and second stages) there follows exact and careful treatment of the wound. All the loose and bruised pieces of muscle which are damaged in their nutrition are excised; the large wound cavity should be doused with sterile salt solution in order that any possible bone particles may be washed away. Then the suture is carefully executed. For this purpose the shoulder is pushed backward and the edges of the wound brought closer together. The muscle suture is done carefully with the catgut button type (1 row in the first stage in the lower portion of the thorax and 2 rows in the second stage in the upper portion of the thorax). I usually put a rubber drain into the large wound cavity after the first stage or in one stage operations and leave it in for 4 hours under the musculature (Fig. 4). Following the second stage the wound cavity is usually smaller and need not therefore be drained. Finally the skin incision is sutured by means of loosely arranged silk button sutures.

As a rule patients tolerate the operation rather well. It is absolutely necessary, however, that a physician observe the pulse and the breathing during the entire course of the operation. It is also almost always necessary to administer a cardiac stimulant in the form of camphor or caffeine during the operation. I also prefer to have the patients drink some hot black coffee or some cognac during an operation which I execute under local anesthesia. Cyanosis is not infrequent during the operation for the patients lie on the healthy lung which is thus inhibited in its breathing excursions. This is of no particular importance as long as the breathing is regular but as soon as marked dyspnea appears the operation should be immediately interrupted and improvement of the patient attempted by means of supine position, oxygen breathing and application of stimulants. It is sometimes advisable to do the operation in 3 stages in case of very weak patients.

Sometimes a tachycardia occurs after the patient has already been placed on the operating table and this may reach 150 beats to the minute. In such cases it is best to wait until the pulse has settled or to give stimulants (cardiazol, camphor, digipuratum). In the majority of cases it is possible to continue as the pulse will drop in rate and the patient become quieter. The tachycardia may be due partly to psychic excitement but if the increased rate persists despite all measures the operation should not be carried out. In one of my patients we were able to operate successfully only after 3 attempts of this kind.

During the operation I always avoid any possible compression of the wound in order to prevent this annoying the patients greatly and disturbs breathing. The dressing should be very loose and I always ban over an assistant's fist placed against the lower part of the sternum during the process. This prevents too tight a bandage. Supine position of the patient is sufficient security for the compression of the wound. This is also the reason why I avoid the non support position of the back. The back should lie on a support and if the bandage is stuck with mastisol or the like it will not be displaced despite its looseness. I don't use the compression pillows recommended by Sauerbruch which are attached to the thorax by means of rubber bands nor have I felt the need to use them.

AFTER TREATMENT

Almost upright supine position of the patient position of the arm of the side operated upon on a pillow all increase the comfort of the patient after operation. It is sometime necessary to apply oxygen for breathing. It is especially

important to use plenty of morphine or pantopon during the first week following operation. The patients then cough more easily. The sputum is usually reduced during the first 2 days following operation, then it becomes even more copious than before operation, but is soon reduced again in quantity. The nurses should be instructed to support the movable side of the thorax every time the patient coughs, and after a few days the patient can do this himself. It is important that the patients cough energetically, and completely, otherwise aspiration into the healthy lung is easy, and this complication is always very serious. In addition to morphine and pantopon, cardiac stimulants must be administered plentifully during the first few days following operation. I consider the use of antipyretics of no great necessity, even if the temperature rises considerably the first few days after operation, as is often the case. After a few days the temperature of itself usually drops to normal.

The interval between the first and the second stage is 1 week, if healing and general condition are good. In the event that healing of the wound is disturbed or the general condition too weak, the interval must be suitably longer. The earlier the second stage is executed, the better and more complete is the collapse. After the wound of the second operation has healed completely, and the patient has regained sufficient strength, he must be transferred to a suitable sanatorium for a period of from 4 to 6 months.

COMPLICATIONS

It is possible that during the process of extracting a rib, one may injure the pleura if the pleural cavity is not completely obliterated. The result is a pneumothorax, which, if it is sacculated, is of no importance. Threatening conditions occur only if the pleura is completely free and the injury leads to mediastinal displacement due to total pneumothorax. In such cases, super-atmospheric breathing must be applied and the pleural wound sutured air-tight immediately. If only a partial pneumothorax occurs, the operation can be continued. In case of total pneumothorax due to injury of the pleura, the operation is interrupted and the pneumothorax left alone. These possible accidents show how important it is to try an artificial pneumothorax before operating.

Another complication is the disturbances in wound healing which occur more frequently if the soft parts have become thickened by lymph stasis before operation. Sörgo in Vienna emphasized the dangers of this complication. In such cases the pleura also discloses a jellied appearance. Wound

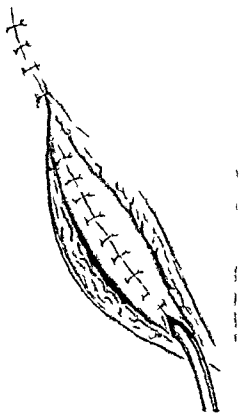


FIG. 4. Closure of wound and drainage tube in place.

healing can take a disturbed course also in case of purulent pleural effusions, and the protracted course can finally be provoked by infection during operation, a circumstance which is not at all impossible considering the size of the wound cavity.

Complications may also arise in the heart and in the other lung during the postoperative course. The latter are especially serious. These complications are either the exacerbation of latent foci or the result of aspirations of sputum containing bacilli in the course of incomplete expectoration and coughing. The pneumonia which may occur at the end of the first or the beginning of the second week after operation is usually fatal.

RESULTS

The effect of thoracoplastic operations depends upon the proliferating component of the process. In the essentially proliferating (productive) types the immediate mortality after thoracoplasty was 3 to 4 per cent, early and tardy fatalities together made up about 10 per cent. Permanent cure and considerable improvement with freedom from bacilli was 70 to 75 per cent. The sputum is free from bacilli a few weeks after operation in some cases. The more the exudative component present, the

worse are results. In these forms the immediate mortality is 25 per cent, the early and tardy fatalities together over 50 per cent. The chances for improvement are not more than 25 to 30 per cent, and in patients over 50 years are even less.

In the event that the operative result is not satisfactory and the process is still unilateral, the effect can be improved by re-operation. This may consist in renewed resection paravertebrally of the upper ribs or anterior parasternal operation. If the cavity is near the anterior wall, the resection

of the anterior rib portions (1 to 4 or 5) leads to better results. Secondary pneumolysis and plugging with paraffin can be carried out, but these are usually difficult because of induration. Phrenicotomy is also possible. This operation I rarely perform before a plastic operation and then only as a test operation. Otherwise I reserve it for repeated pulmonary hæmorrhages. Even in very obstinate cases I have repeatedly been able to secure cure or freedom from bacilli by means of one or more operations.

BLASTOMYCOSIS OF THE ESOPHAGUS¹

REPORT OF A CASE

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t. a. s. g. i. p. t. h. l. g. y. M. y. C. l.

AND

HAMILTON MONTGOMERY, M.D., ROCHESTER, MINNESOTA
t. l. l. w. D. m. t. l. o. g. y. d. s. y. p. h. l. l. g. y. T. h. M. y. F. d. t.

BLASTOMYCOSIS of the skin with generalized dissemination of the disease is no longer considered rare. Many such cases have been reported by Montgomery and Ormsby, Stober and Wade and Bel, the last observers having reviewed the postmortem data in 47 cases.

It is of interest that the esophagus was involved once only in this series of cases. The patient was observed by Shepherd and Rhea and succumbed to generalized blastomycotic infection. At the postmortem examination a fluctuating area 1 centimeter in diameter was found 7 centimeters above the cardia. Every organ of the body was involved in the process except the

brain. The patient did not have symptoms referable to the esophagus.

New reported a case of primary blastomycosis of the tongue without dissemination, and Jackson, Dennis and Downing have each observed a case of primary blastomycosis of the larynx, but we have been unable to find reference to any case in the literature in which the disease was primarily in the esophagus. We are therefore reporting a case recently observed in the Mayo Clinic.

A man aged 41 years, who had resided in Chicago for a number of years, was examined April 11, 1917. Twelve years previously he had had pulmonary tuberculosis and bacilli of tuberculosis were found in the sputum. After a period of 4 months in a sanatorium, there followed a period of excellent health for 11 years. During this time the patient had followed a strict hygienic regimen, sleeping on a porch at night. His work as an accountant was done in comfortable surroundings. Nine months previous to examination at the Mayo Clinic, he noticed obstruction in the upper portion of the esophagus to the passage of solid food. This had progressed slowly to the point where soft foods were taken with little difficulty. Esophagoscopy



Fig. 1. Structure of the upper third of the esophagus from blastomycosis.



Fig. 2. Tissue from blastomycotic granuloma showing budding organisms.

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STABILIZATION OF THE SHOULDER JOINT FOR HABITUAL DISLOCATION¹

BA HANS SPIEZY M D V E N A A L TRI

P f (O h ped s g y

THE shoulder joint is frequently the site of habitual dislocations which cause disturbances of function. Even if the recurrence does not produce such violent reactions as the primary dislocation produces nevertheless the uncertainty and the anxiety that redi location may occur cause interference with working efficiency. Because the joint is relaxed the least movement of the arm backward either by eleva-

tion or by the supporting of the arms in a backward position causes redislocation of the shoulder joint (forward anteriorly).

All of the well known methods of rehabilitating the joint have some weak point. Capsulorhaphy alone is seldom satisfactory. By the complicated muscle plastics of Clairmont and Finsterer some degree of fixation may easily be secured with impairment of motion in the shoulder joint. Considered from the point of view of redi location this is an advantage but from that of working capacity it is not so valuable.

Therefore another method was devised for fixation of the arm to the acromion the transfixation of fascial straps. By this method the range of motion of the shoulder joint is preserved and at the same time the chances of redislocation are reduced to a minimum. The method is as follows.

With a curved incision the insertion of the deltoid muscle is exposed. The muscle is separated from its insertion and the main flap retracted upward. If it is carefully borne in mind that the distribution of the axillary nerve is in the back part of the flap injury to it can easily be prevented. After the capsule has been exposed a silk ligature double four ply strong (Turnersilk) is passed

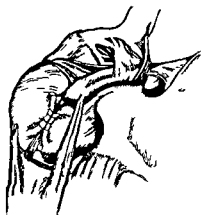


Fig. T h q e of the p t n

T l t d by L L R h M D V A A L C T r



Fig 1

with a specially bent elevator perforated at the end around the surgical neck of the humerus and a double knot is made on the anterior side over the joint. We therefore have four strong silk ligatures parallel to each other on the anterior surface of the joint. These are transfixed and well knotted to the coracoid process which is well exposed. The origin of the biceps muscle which is on this process prevents the slipping of the ligatures. The four threads form a strong band lying on the anterior surface of the joint. The capsule on both sides of this band is now lifted and the folds are sutured around the silk band. Therefore the sheath in which the silk band now lies is exactly similar to that of the tendon of the long head of the biceps muscle passing the shoulder joint.

We have therefore at this point which is the weakest point an artificial reinforcement of the capsule and also a shortening of the joint capsule space which we have gained by the folding over.

It should be explained that the silk thread which we use has a tensile strength of 40 kilograms (86 pounds) so that with one ligature we have a resistance of 80 kilograms and with the entire band a resistance of about 160 kilograms.



Fig 2 Before the operation dislocation occurred as much as 20 times a week. Since the operation (1924) dislocation has not occurred once. The pictures show the normal amount of motion after operation.

The flap is now replaced and with perosseous sutures the deltoid tendon is fastened at the place of its insertion on the humerus.

After a period of rest of 4 weeks the patient begins careful exercises.

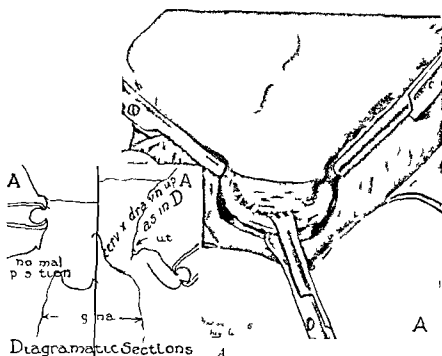
In the cases operated upon by this method the patients recovered complete working capacity and regained free motion in the joint. Dislocation which had been common at short intervals never recurred.

A SIMPLE METHOD OF REMOVING THE CERVIX WITH THE UTERUS IN HYSTERECTOMY

By FRANK H. LAHEY, M.D., F.A.C.S., Boston

IN July, 1923¹ we published a description of a method of excising the major portion of the cervix with all of the cervical canal in hysterectomy for benign lesions. On account of the good results following its use in several cases we recommended its employment because it had resulted in the desirable accomplishment of excising practically the entire cervix together with the uterus without added danger to the ureters

with but slight added difficulty to the operation without shortening the vagina during the period of sexual activity and with preservation of the cervical shell into which the broad and round ligaments are inserted thus preserving a valuable structure for the support of the vagina and bladder. Further employment of this procedure in the clinic has not lessened our satisfaction with it. We have now employed this technique in 12 hysterectomies with complete satisfaction and



Diagrammatic Sections A

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again wish to direct attention to its value as well as to add a few technical steps developed after further experience which make the operation easier

Transcervical removal of the cervix should be undertaken only in those cases in which an adequate exposure of the cervix and pelvic fossa can be obtained. This will be possible in practically all cases except those in which the size of the uterine tumor together with inability to deliver it will prevent satisfactory demonstration of the complete circumference of the cervix down to its attachment to the vagina. In cases presenting difficulty in exposure a simple transverse incision of the cervix with no attempt at cervical removal will be safer and more satisfactory.

As stated in the original description of this operation bleeding and oozing during the excision of the cervix is considerably greater than during the simple supracervical hysterectomy and is the greatest drawback to the operation. At no time however has bleeding been uncontrollable or excessive in our hands. It has been bothersome only

in that it lessens the neatness of the appearance of the operative field. While the neck of the uterus is being excised from its cervical shell the oozing is considerable but is immediately controlled as soon as the vaginal supports are sutured into the cervical shell. By the introduction of the corner of a folded towel into the fossa of Douglas we have succeeded in catching the small amount of blood which comes from this oozing so that after the mattress suture in the cervical shell is inserted the suture of the cervix completed and bleeding controlled the towel with any small accumulation of blood clots on it may be lifted out of the pelvis.

The particular point which we wish to demonstrate is the application of double hooks such as we have employed in goiter surgery to the front and back of the thin shell of cervical tissue which is to be left behind so that with one assistant pulling up on the uterus and the other pressing the anterior and posterior double hook downward the shell of cervix which is to remain may be gradually everted as the excision of the cervix is

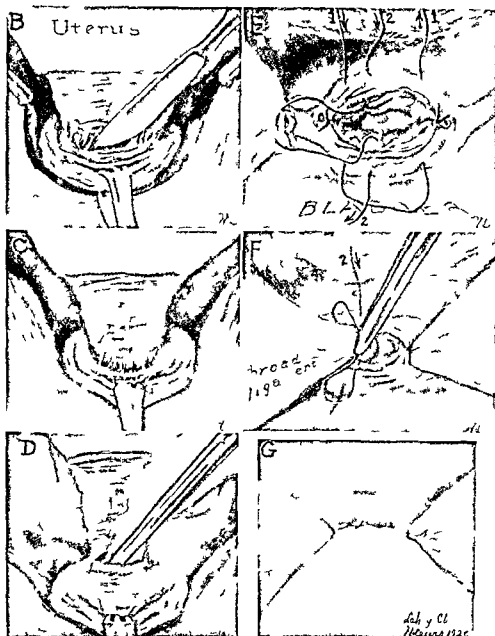


FIG B The anterior double hook only 1 shown attached to the shell of cervical tissue which is being pushed downward as the uterus is pulled upward and the dissection of the cervix continued

FIG C The same further advanced showing the fold which develops between the cervical shell and the cervix and in which the dissection should be carried out

FIG D The cervix completely dissected the opening into the vagina made on the anterior wall and the thin strip of gauze being passed through it into the vagina. As soon as all of the gauze has been passed into the vagina so that no vaginal secretions may flow back up into the peritoneal cavity the cervix is completely detached from its vaginal attachments

FIG E The cervical remnant seen from above. The inverted shell has been inverted and the gauze strip in the vagina may be seen. The mattress suture *r-r* is shown grasping the entire cervical shell and introduced low down the bladder having been wiped off in front. This stitch must be accurately introduced as it is the stitch which prevents postoperative bleeding into the vagina

FIG F The broad and round ligaments separately or together may be introduced and sutured deeply in the shell. The mattress suture should be tied last after introduction of the ligaments to the cervical pocket and closure of the cervix

FIG G The usual peritonealization of the stump

carried down to its vaginal attachment just as a finger is extracted from a finger cot by grasping the base of the cot and pulling the finger out of it.

The technical steps of the operation may be grasped from the Figures 1 to 7 with the attached legends.

The introducing into the vagina of a strip of gauze which has been unfolded and pulled out into a narrow ribbon is of advantage in keeping the secretions of the previously painted vagina out of the cervical shell and providing a small pack at the vaginal orifice of the cervical shell to control any small oozing not taken care of by the cervical sutures and mattress stitch.

In describing any operative plan which differs from those commonly employed it should be the duty of the describer to set down any complications which have arisen in its use. Therefore it is only fair to say that in 6 of the first 10 cases in

which this scheme of cervical removal was employed there was so much uncontrolled oozing into the vagina from the canal of the cervical shell that re-etherization and suture of the lower end of the cervical shell through the vagina was necessary.

Since the early cases however since we now wipe the bladder well off the anterior surface of the cervical shell and upper vaginal wall so that the mattress stitch for control of oozing may be placed low in the cervix close to its attachment to the vagina no further difficulty of this nature has arisen and vaginal suture of the cervix has never been necessary.

From our experience with the procedure we know of no drawback to its use and recommend its employment in all patients upon whom hysterectomy is performed for a benign lesion in which adequate exposure of the cervix may be obtained.

SURGICAL PROCEDURE IN OBLITERATIVE VASCULAR DISEASE (THROMBO-ANGIITIS OBLITERANS)

A REPORT OF FORTY FIVE CASES

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S. O. H. D. Y. M. S. C.

OBLITERATING thrombo-angitis (Buerger's disease) usually affects males between the ages of 17 and 40 years. Juvenile and presenile gangrene have been used to designate the obliterative vascular lesion occurring chiefly in the extremities which is now known as thrombo-angitis obliterans. Buerger first described the condition as a definite pathological entity and clearly demonstrated the essential differences between this condition and arterio-sclerotic disease of the extremities.

Excessive fatigue of the extremities or claudication pain brought on by exercise and relieved by rest is experienced early and is manifested by pain in the calf, hand, arch or single digits. Soon after or coincident with the color changes there is a continuous burning or aching pain largely limited to the digits, not related to exercise and partially relieved by the dependent position and heat. With the occurrence of marked trophic changes such as non-healing incisions or gangrene

this pain becomes sharp, is unrelieved by usual measure and frequently is unbearable requiring amputation for relief.

Objectively the earliest manifestation is the bluish red discoloration of the digits increased by the dependent position and minimized by elevation (Fig. 1). The extremities are cold and there are diminished or absent pulsation of the arteries and mild trophic change such as abnormal calluses and linear breaks in the skin. Later, by gangrene may occur spontaneously but is more often incited by trauma, incision or infection. In approximately 95 per cent of the cases the complaint is referable chiefly to the lower extremities. In 30 per cent there is some degree of arterial obliteration in the upper extremities. Symptoms are rarely referable to this region. Pathologically the process is an inflammation affecting primarily the main arteries and veins of the extremities. An obliterating thrombus occurs which successively undergoes organization and fibrosis (Fig. 2). The



Fig. 1. Foot in a case of thrombo-angitis obliterans. In the dependent position there is bluish red discoloration of the toes and distal part of the foot. The fourth toe is gangrenous and the impending gangrene of the great toe. A small area of superficial phlebitis is present above the second and third toes.

end stage is an organized thrombus in which new vascular channels occur. These are at first discrete; later they are fused into larger channels. Perivascular fibrosis binds together the nerve, artery and vein.

CASES STUDIED

In approximately 80 per cent of the 100 cases in this series a diagnosis had not been made or it had been made incorrectly previous to the patient's admittance to the Mayo Clinic. In the stage of the disease when the toes become red and painful and with symptoms and signs indicating an insufficient blood supply incisions for deep-seated infection or removal of ingrown toe nails are frequently carried out. Gangrene is initiated by this procedure in 35 per cent of the cases. This is significant since the outlook for eventual recovery is greatly lessened in the presence of gangrene or non-healing incisions. Toes are amputated in cases in which there is obstruction of the proximal vessels and if the blood sup-

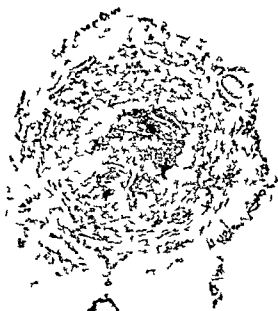


Fig. 2. An artery in a case of thrombo-angitis obliterans. The lumen is occluded by an organized thrombus in which new channels have formed. There is lymphocytic infiltration of the arterial wall and surrounding tissue and many newly formed vessels in the periarterial tissue.

ply is inadequate. Nonhealing of the incision followed by gangrene is the result. Amputation is frequently performed above the knee without sufficient consideration of the necessity of a functioning knee joint. This is important in thrombo-angitis obliterans which occurs usually among young persons dependent for a livelihood on the maintenance of function in the lower extremities. Amputation below the knee may be unsuccessful but usually because valuable methods which may be easily utilized and which increase the possibility of primary healing are neglected.

It is our purpose here to analyze carefully these surgical procedures. In a group of 150 cases of thrombo-angitis obliterans observed in the years 1913-1916 surgical procedures were carried out in 45 cases at the Mayo Clinic or elsewhere. These 45 cases form the basis of this report. In all instances the term "successful" refers to healing by primary intention. Prolonged healing refers to healing prolonged for months or more and "unhealing" refers to the condition at the time of observation or at the time of latest information.

SURGICAL PROCEDURES

The surgical procedures of incision or amputation in thrombo-angitis obliterans can be conveniently grouped as (1) incision of toes or removal of toe nails, (2) amputation of toes, (3) amputation below the knee and (4) amputation above the knee.



Fig 3

Fig 4

In 3 of the 15 cases of successful incision of the toes or removal of the toe nails, the incision was made on the dorsal aspect of the foot. In 1 case of prolonged healing, higher amputation was performed later. In 13 cases in which incisions did not heal, higher amputation was required in 9. In the remaining 4 cases, the incisions had not healed at last reports, and there is a probability that higher amputation will be necessary.

Incision of toes or removal of toe nails In 15 cases the incision of toes or removal of toe nails (elsewhere) was successful in only 1 case (Table I) in which higher amputation was later required for a similar condition in other toes. In 1 case of prolonged healing, higher amputation was performed later. In 13 cases in which incisions did not heal, higher amputation was required in 9. In the remaining 4 cases, the incisions had not healed at last reports, and there is a probability that higher amputation will be necessary.

Amputation of toes Toes were amputated in 6 cases at the Mayo Clinic (Table II). The operation was successful in 4 cases. Incisions did not heal in 2 cases in both of which higher amputation was required later. Amputation was carried out in these 2 cases at the insistence of the patients. In 25 cases 1 or more toes were amputated elsewhere. In 5 of these healing was prompt but in 1 amputation at a higher level was later required. In 10 cases healing was prolonged in 3 of which amputation at a higher level was necessary. In 9 of the cases in which amputation was done elsewhere, the incision failed to heal and higher

amputation was later necessary in 7. The probability of higher amputation at a later date in the 9 cases in which healing was designated as prolonged or absent must be considered. Of the 31 cases in which amputation was performed at the Mayo Clinic and elsewhere, healing by primary intention occurred in 9. In 3 of these in which amputation was done elsewhere, the available data are not sufficient for consideration. In 3 of the 6 remaining cases, sudden thrombosis occurred in 1 or toes and in of these the vessels of the feet pulsated normally. In the 3 other cases, pulsations were normal in either the dorsalis pedis or posterior tibial vessels. In the successful cases, the average pulsation in the dorsalis pedis vessels was 1 and in the posterior tibial 1 to 2 (on a scale of 0 to 4). In the unsuccessful cases, the average

TABLE I—RESULTS OF INCISION OF TOES OR REMOVAL OF TOE NAILS IN FIFTEEN CASES (OPERATION ELSEWHERE)

Case	Result
1	Successful incision, healing prompt
2	Prolonged healing, higher amputation required
3	Unhealed incision, higher amputation required
4	Unhealed incision, higher amputation required
5	Unhealed incision, higher amputation required
6	Unhealed incision, higher amputation required
7	Unhealed incision, higher amputation required
8	Unhealed incision, higher amputation required
9	Unhealed incision, higher amputation required
10	Unhealed incision, higher amputation required
11	Unhealed incision, higher amputation required
12	Unhealed incision, higher amputation required
13	Unhealed incision, higher amputation required
14	Unhealed incision, higher amputation required
15	Unhealed incision, higher amputation required

TABLE II—RESULTS OF AMPUTATION OF TOES IN THIRTY ONE CASES (SIX OPERATIONS IN MAYO CLINIC AND TWENTY FIVE ELSEWHERE)

Case	Mayo Clinic	Elsewhere
1	Successful incision, healing prompt	Successful incision, healing prompt
2	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
3	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
4	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
5	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
6	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
7	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
8	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
9	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
10	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
11	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
12	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
13	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
14	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
15	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
16	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
17	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
18	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
19	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
20	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
21	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
22	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
23	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
24	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required
25	Unhealed incision, higher amputation required	Unhealed incision, higher amputation required

TABLE III—RESULTS OF AMPUTATION BELOW THE KNEE IN TWENTY ONE CASES (TWELVE OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

	Mayo Clinic	C
Successful not requiring higher amputation	9	
Prolonged not requiring higher amputation	1	
Unhealed requiring higher amputation	2	
Elsewhere		
Successful not requiring higher amputation	6	
Prolonged not requiring higher amputation	1	
Unhealed requiring higher amputation	1	
not requiring higher amputation	1	

pulsation in the dorsalis pedis vessels was 0 to 1 and in the posterior tibial 0

Amputation below the knee Amputation was performed below the knee in 12 cases at the Mayo Clinic (Table III). Healing occurred by primary intention in 9 cases it was prolonged in 1 and absent in 2. Accessory measures to stimulate healing were not carried out in either of these 2 cases both of which required higher amputation later. In 9 cases amputation below the knee was performed elsewhere in 6 healing was prompt in 1 it was prolonged and in 1 it was absent. In 1 of the latter amputation at a higher level was necessary later. In the total of 21 cases healing by primary intention occurred in 15 cases (71 per cent) and was delayed in 10 per cent. In only 4 cases (19 per cent) was there failure to heal. A comparison of the successful and unsuccessful cases shows only insignificant variations in average age, average amount of rubor with the foot dependent, average amount of pallor with the foot elevated and in the average severity of the rest pain. In the unsuccessful cases the average duration of symptoms was 6 years, twice that in the successful cases. Pulsation in the popliteal, dorsalis pedis and posterior tibial vessels was always absent in the unsuccessful cases, but sometimes present in the successful cases. Pulsation however was absent in the popliteal artery in some cases in which amputation below the knee was successful.

Amputation above the knee This operation was performed at the Mayo Clinic in 7 cases (Table IV). In 6 of these healing was prompt and in 1 it was prolonged. In 1 case high amputation was performed because of extensive gangrene of the foot and deep gangrenous ulcers over the tibia and knee. In 1 it was performed because of previous unsuccessful amputation below the knee. In 1 because of previous unsuccessful amputation of the toes and in 1 because the patient was admitted with extensive gangrene of the foot and was extremely toxic because of absorption from the

TABLE IV—RESULTS OF AMPUTATION ABOVE THE KNEE IN SIXTEEN CASES (SEVEN OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

	Mayo Clinic	C
Healed not requiring higher amputation	6	
Prolonged not requiring higher amputation	1	
Elsewhere		
Healed not requiring higher amputation	8	
Unhealed not requiring higher amputation	1	

gangrenous area. In the 3 remaining cases amputation was performed above the knee at 2 times when high amputations were thought necessary. Amputation above the knee was performed elsewhere in 9 cases in 8 of which healing was prompt it was prolonged in 1 case.

DISCUSSION

The indications for amputation are not clearly defined in cases of thromboangitis obliterans. Careful observation of such cases has shown that function in the diseased extremity is reestablished in many cases by medical treatment. This is true in cases of gangrenous ulcer which heals spontaneously or in cases of gangrene in which autoamputation occurs. Mills states that autoamputation of the toes frequently occurs in the stoic Chinaman and function in the foot remains. Several cases of this type have been observed at the Mayo Clinic (Fig. 1).

The economic factor in cases of thromboangitis obliterans cannot be overlooked. The disease usually occurs in patients with limited finances. Whether it is better to treat a patient medically over a period of months or years with almost complete disability during this time and with uncertain results or to proceed with more radical treatment with the hope of a shorter period of economic loss is a question. There is no general solution of this problem. Each case requires individual consideration. Either intrinsic pain or gangrene extending above the toes is always a clear cut indication for operation. Pain may frequently be relieved by the repeated use of vicinex (3) by radium chloride (1) and in selected cases by lumbar ganglionectomy (3). In our experience gangrene of such severity has not healed spontaneously. Cases of gangrene affecting only the toes in whole or in part should be treated medically; provided pain can be relieved and economic conditions permit it.

Cases treated surgically should also be treated medically to increase the blood supply postoperatively, especially if the success of the operation is doubtful. The application of radiant heat by

means of the carbon filament electric bulb arranged in an arch over the bed is helpful and should be given for from 2 to 4 hours twice daily. Care must be used to avoid burning. Triple typhoid vaccine is of value if given intravenously in amounts sufficient to produce a mild chill and a systemic fever of 2 or 3 degrees Fahrenheit. The usual amount is from 10,000,000 to 50,000,000 killed organisms. This treatment can be begun on the third day after operation and given daily or on alternate days. Postoperative complications such as pneumonia or shock are contra-indications. Brown has shown that this method of treatment increases the temperature of the skin and the rate of heat elimination from the extremities. With increased blood supply to the extremities healing is facilitated.

The level for amputation needs careful consideration. There are no indications for the incision of toes or the removal of toe nails. The frequency with which these procedures are carried out indicates a definite lack of knowledge regarding the nature of the disease process. The two misleading symptoms are pain and redness of the toes. The obvious inference is that a deep seated infection exists. This in a measure is true but the absence of heat in the digit, the presence of similar rubor of lesser degree in other toes, the absence or diminution of pulsation in the main arteries of the feet, the history of or presence of superficial phlebitis or the presence of symptoms indicating vascular occlusion (excessive fatigue or pain of the calf arch or ankle) give ample evidence of an underlying obliterative vascular disorder. Non-surgical method for relief of the pain consisting of the intravenous injection of foreign protein (3) or sodium chloride (1) protection of the extremities from trauma and medical and physical measures to increase the blood supply (3) are indicated in these cases. If pain can be relieved and trophic changes avoided sufficient circulation may be eventually established.

The amputation of toes may be successful in 2 types of cases: those in which there is sudden thrombosis of the vessels of the toes and those in which either or both of the main pedal vessels pulsate normally indicating that the vascular occlusion is distal to these areas (Fig. 4). Thrombosis of the toes is manifested by sudden bluish black discoloration usually of 1 or more toes with failure of return to normal color within 3 or 4 days. In our experience this occurred in cases in the early or middle stage of the disease with but little other evidence of obliterative vascular disease. It constituted an early sign of organic obliterative lesion of the arteries. Amputation in cases

of thrombosis of the toes is only justified if there are open vessels and the limb appears normal proximally.

Amputation of the distal half of the foot or above the ankle has not been attempted. Healing would not be expected to occur at those levels and even in successful cases the function would not be better than in cases successfully amputated below the knee.

Amputation in the region of the knee is necessary in cases of intractable pain or of gangrene of the toes or feet unless it is possible to amputate the toes successfully. Amputation below the knee is not commonly acknowledged to be successful. Buerger reported 63 cases in which he performed the Gritti Stokes amputation above the knee and believed this to be the most satisfactory operation. Telford and Stopford were of the same opinion. Jablons believed that 50 per cent of his cases were suitable for amputation below the knee.

In our series of 1 cases in which amputation was performed below the knee there was healing by first intention in 15 cases (70 per cent). In other cases healing was prolonged. The importance of a functioning knee joint obtained by amputation below the knee cannot be too strongly stressed.

Criteria for selection of the area below the knee are not definite. Buerger believed that methods or tests for estimating the point at which operation should be done are all unreliable. Meleney and Miller amputated below the knee in all cases if there was pulsation in the popliteal artery, and above the knee in all cases in which the popliteal artery was occluded. The results were not encouraging. Bean advised amputation above the site of closure of the main arteries. In many of our cases of successful amputation below the knee the popliteal artery was completely occluded. In cases of oedema of the leg of extensive gangrene of the foot and leg, of gangrenous ulcers over the tibia or knee or of extensive cellulitis and lymphangitis the chances for successful amputation below the knee are less. In all other cases there is roughly an 80 per cent probability of primary healing provided postoperative methods for increasing the blood supply to the stump are utilized. Attempts should be made to remove the oedema by means of elevation and diuretics such as ammonium chloride and merbaphen. The patient is usually willing to take the 80 per cent chance for successful amputation below the knee in order to have a functioning knee joint. This is explained and left optional with the patient. Later amputation at a higher level in unsuccessful cases is not attended by an increased risk except in patients of

more advanced age whose gangrene is arterio-sclerotic in origin. Amputation above the knee should be reserved for cases in which previous amputation below the knee was unsuccessful for cases in which infection or trophic changes are extraordinarily extensive and for patients unwilling to take the 50 per cent chance of failure of amputation at a lower level.

SUMMARY

Incision of toes or removal of toe nails should not be performed in cases of thromboangitis obliterans. Amputation of toes can be successfully accomplished in selected cases. In approximately 80 per cent of all cases (excluding those complicated by oedema, cellulitis or extensive gangrenous changes) amputation below the knee can be successfully carried out provided post-operative medical measures to increase the blood supply to the stump are instituted. These results demonstrate the value of close co-operation between the clinician and the surgeon. Such results

cannot be obtained in older patients whose gangrene is arteriosclerotic in origin.

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THE DELIVERY OF THE ADHERENT PLACENTA

REPORT OF THREE CASES IN WHICH THE MOJON GABASTON METHOD WAS EMPLOYED¹

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Att. d. g. Obst. d. Gy. ol. i. t. Syd. h. m. H. p. t. l. Att. d. g. Gy. l. g. t. B. th. D. I. H. p. t. l. f. H. m. f. th. D. g. h. t. f. Ab. h. m.

MANUAL removal of the adherent placenta is one of the most dangerous procedures in obstetric practice. According to Bumm (5) there is a 10 per cent mortality following this operation and the morbidity from uterine infection has been variously estimated in the neighborhood of 25 per cent. Infection from implantation of the micro organisms at the placental site, hemorrhage during and after the operation, shock due to the extraction and occasionally rupture of the uterus are the hazards of manual removal.

In the Mojon Gabaston method we have a means of effecting the delivery of the adherent placenta without intrauterine exploration. Briefly this method consists in the injection of warm sterile saline solution into the placenta by way of the umbilical cord vein so as to distend and rupture the placental vessels and form a retroplacental hydroma; then separation of the placenta takes place in response to the mechanical action of this hydroma.

The value of so simple a method of delivering the adherent placenta is apparent. Even in a well equipped hospital it has obvious advantages over manual extraction when it proves effective. And to the physician who must work in small communities and conduct his operations under conditions in which sepsis is imperfect, it offers a special appeal. To the practitioner who finds himself confronted with the problem of an adherent placenta while delivering his patient in a country home where trained assistants cannot be had, an alternative to manual extraction is certainly of advantage. Furthermore in cases of precipitate labor when there is no time to shave and prepare the external genitals properly, the danger of intra-uterine interference is considerably increased, then the Mojon Gabaston method offers greater safety.

It is for these reasons that I am reporting three cases in which the use of the Mojon Gabaston method brought about prompt delivery of the adherent placenta with an uneventful recovery.

MANUAL EXTRACTION DANGEROUS

It is usually assumed that the placenta is abnormally adherent when it is not delivered within hours after childbirth. In my experience however what is termed an adherent placenta often proves to be only retention brought about by partial closure of the retraction ring. This view is supported by the opinions of other workers. Williams (9) states: "In the vast majority the term *adherent placenta* is a misnomer since the interference with its expulsion is usually due to abnormalities in the uterine contractions rather than to abnormal adhesions between it and the uterine wall." According to Edgar (11) adhesions between the placenta and the uterine wall are of rare occurrence for the majority of cases thus characterized are only instances of simple retention.

Practically all authorities emphasize the dangers of manual extraction. Williams (30) advises waiting for at least 2 hours during which time repeated attempts are to be made to effect expulsion of the placenta by the Crede method. Of course if the condition of the patient is serious or there is free bleeding manual extraction must be instituted earlier. Williams holds that manual removal of the placenta must never be undertaken unless this course seems absolutely necessary as it is a more serious procedure than most obstetric operations. He points out that in the performance of a manual removal the hand introduced between the placenta and the uterine wall and therefore comes in direct contact with the freshly thrombosed vessels at the placental site which afford an excellent culture medium for the bacteria thus implanted. In other obstetric operations on the contrary the hand or instrument touches the amniotic surface of the placenta consequently if any infection is introduced it is expelled with the placenta.

Leavitt (17) holds that manual detachment of the placenta should be undertaken only when other measures fail not omitting their trial under narcosis. According to Sacharow (23) the manual removal of the placenta is always a serious procedure which should be performed only after the Crede method has been tried and injection of the placenta has failed. One must bear in mind that the fundus of the uterus is thinned out during pregnancy. Consequently if the placenta is adherent at the site of the attenuated fundus the uterus may be ruptured during attempts at manual removal or even by too forcible Crede expression. Such cases have been reported. In some instances an attempt at manual extraction has resulted in boring a hole

through the fundus and bringing down a loop of intestine through the rent.

The mortality and morbidity statistics following manual extraction of the placenta confirm the general opinion as to the serious nature of this operation. As has been stated before Bumm (5) attributes a 10 per cent mortality to this operation. This estimate corresponds closely to an average of all the available statistics on the subject. With regard to morbidity statistics Bourne (4) reported 54 cases of uterine sepsis 35 per cent in a series of 154 manual extractions. Goethals (14) collected a series of 156 cases with uterine infection in 39.5 per cent.

It is apparent that manual removal of the placenta is a hazardous procedure even under the best of conditions. When the operation must be undertaken in a private home without trained assistants the dangers are greatly multiplied. Therefore an alternative procedure of removing the adherent placenta without the necessity of introducing the hand into the uterus should prove of great value. And there is reason to believe that the Mojon Gabaston method does indeed fill this field of usefulness.

DEVELOPMENT OF MOJON GABASTON METHOD

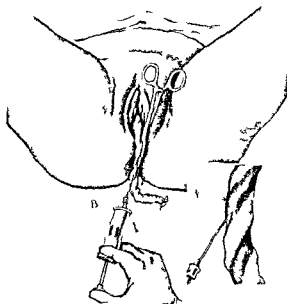
In 1914 Gabaston (13) of Buenos Aires reported an improved and satisfactory technique for the hydraulic removal of the adherent placenta a method first described by Mojon (20) of Genoa in 1866. It will be of interest to review briefly some of the outstanding reports concerning this procedure.

Mojon in 1866 described his method as follows: "Water slightly acidulated with wine is injected with some force through the vein of the umbilical cord into the placenta after allowing the flow and expressing of as much blood as possible from this vein by way of precaution. Whether because of the sudden pressure which the injected water exerts in the fetal placental tissue or the cold which is immediately transmitted from the placenta itself to the placental site of the uterus in any event the desired separation takes place without the necessity of introducing the hand into the uterus. In case the first injection does not prove effective a second one may be attempted after the liquid previously injected has been evacuated."

Asdrubali (1) of Pome in 1826 claimed priority for the method stating that he had lectured to his students since the year 1814 that if spirits of wine is injected into the vein of the umbilical cord it penetrates the entire mass of the placenta and diffuses even into the finest



F S m d a m m a t p t t i m u l
 tr ct of th plac t h l th t t e
 h d m n l t t t t l th f hly th mb l
 pl nt l nu I th b t t c l e t th h d
 t h the u f f th m n t th b t
 Th t hy th d f n f t f m m l t a t
 of th pl nt p l l v g at



F 3 Tl p f m f th M J C b t m th
 d f Th j t f m t l m l l e sol
 t to th u bil l l Th m d e h ld
 pl c by th t y l m l B Th p t n f th y
 nd n ll h n l t m l l n f th h
 h v t l dl t du d t th m l l d
 p all i th t Th n s d t t l t n d

and vinegar into the retained placenta is of course a procedure that would never have been attempted were it not for the fact that there was no knowledge of bacteria at the time when this procedure was first employed.

The older literature shows that the Mojon method was employed by many obstetricians with a certain amount of success but with occasional mishaps due to the crudities of the procedure and the lack of asepsis. As much of this work was performed before the era of bacteriology the unfavorable results due to infection cannot greatly influence our appraisal of the Mojon Gabaston method as now employed. However the reader who wishes to obtain more details on this subject will find a complete survey of the literature in the article by Koerting (16) published in both German and Spanish.

RECENT REPORTS ON GABASTON'S TECHNIQUE

Gabaston's favorable report has been confirmed by a considerable number of other workers but very few of these papers have appeared in English. Traugott (7) in 1917 reported five cases in which placentas retained from 70 minutes to 15 hours were easily removed by this method. In the Frankfurt Clinic the results were reported

in 158 cases of placental injection and the ratio in which manual extraction was required was reduced from 47 cases per thousand in 1911-15 to 1 in 1916. Schwarz (4) in 1920 employed the method successfully in 11 of 16 cases 2 of the 5 unsuccessful cases proving to be placenta accreta. Wagner (8) of the German University in Prague favors the Mojon Gabaston method and maintains that the incidence of rare removal of the placenta has thereby been reduced exactly one half. He is of the opinion that the Mojon Gabaston method is destined to replace not only manual removal of the placenta but also the Crede method of expression. In this view he may be a little overenthusiastic. Chaiton (8) also effected a 50 per cent reduction in the number of cases requiring manual extraction by means of the hydraulic method.

Hammerschlag (15) in his *Lehrbuch der operativen Geburtshilfe* comments favorably on the Mojon Gabaston method and cites a case in which it was used successfully. Doederlein (9) too in his *Handbuch der Geburtshilfe Operationslehre* makes mention of this method.

Cathala and Biancani (7) recommend hydraulic expulsion of the placenta after a difficult delivery of the child when the mother is still under the

anæsthetic as it avoids the necessity of prolonging anæsthesia. They believe that the method is contra indicated in uterine inertia as it does not stimulate uterine contractions.

Pamos and Perez (22) in 1921 employed the Mojon Gabaston method in 8 cases of adherent placenta and were able to confirm the general impression as to its harmlessness and efficacy. In one case of twins with two placentas the hydraulic method proved exceptionally useful. In three cases of placenta previa the injection was made immediately after the birth of the child and the result was favorable in each case.

According to Koertung (16) distention of the placenta following injection of fluid through the umbilical cord vein often makes Crede expression and manual extraction of the placenta unnecessary. He is of the opinion that in order to obtain the full effect of the injection the physician should not employ expression previously. If the Crede manipulation becomes necessary the hydraulic distention of the placenta renders it more effective. Koertung believes that when there is profuse hæmorrhage or the amount of blood lost is unknown the Mojon Gabaston method is contra indicated.

Goethals (14) of Boston believes that the Mojon Gabaston method is the procedure of choice in cases of retained unseparated placenta without hæmorrhage and that it also deserves trial when there is slight hæmorrhage with partial separation however he does not believe that it can replace manual extraction when there is brisk hæmorrhage or prompt action is required.

It is not advisable to employ the Mojon Gabaston method as a routine procedure in all deliveries. Wuhrmann's (31) statistics covering five hundred cases in which it was used as a routine show that it has many disadvantages over expectant treatment. The duration of the third stage of labor and the amount of hæmorrhage were increased. However Wuhrmann holds that retention of the placenta constitutes an indication for the Mojon Gabaston procedure as a routine measure when there is a history of abnormal expulsion of the placenta in previous labors.

Forget (12) in 1924 reported a case in which the use of the Mojon Gabaston method gave an unfavorable reaction. Because the placenta was not expelled in half an hour water was injected into the umbilical cord vein. Gentle traction was then made on the cord and the placenta was delivered without difficulty. Half an hour later however the patient had a severe chill lasting several minutes. The author attributed this

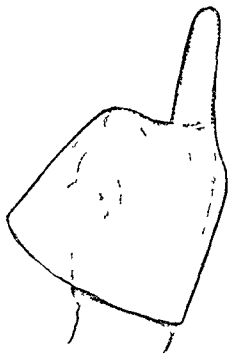


FIG. 4. Hand prepared for rectal examination. The position of the finger is shown the glove is indicated by the dotted line.

untoward result to the entrance of the water into some of the uterine veins and advises caution in the use of this method of delivering the placenta. It does not appear however that when warm sterile saline solution is used this reaction is likely to occur.

Some observers including W. Stoeckel (6) advise earlier and more frequent manual removal of the placenta. If the placenta is not expelled soon after the injection of the saline the patient is anesthetized and expression by Crede's method attempted. If there is no success manual extraction is employed. One must not forget to catheterize the bladder before attempting artificial delivery of the placenta. In H. Bergmann's hospital (3) drugs are injected into the uterus through the abdominal wall and this procedure is also used before expulsion of the placenta. Although permissible in cases of great uterine atony following expulsion of the placenta injection of drugs into the uterus through the abdominal wall is not generally recommended.

TECHNIQUE OF PROCEDURE

The method of performing the Mojon Gabaston method is quite simple. Saline tablets for the purpose of making the physiological salt solution may be obtained at any drug store. According

to the strength of the tablet used from one to three are added to the required amount of water and this salt solution is sterilized by boiling. The average tablet is sufficient to make a normal saline solution from 4 ounces of water in any event the strength of the tablet is stated on the package.

When used the saline solution should be warm. As a general rule from 200 to 300 cubic centimeters of fluid are required more if a second injection is given. The injection is made by means of a sterile Record or Luer syringe of from 20 to 100 cubic centimeters capacity. Sometimes the introduction of 100 cubic centimeters is sufficient.

It is best to insert the needle into the cord close to the pudendum as this portion is less likely to be soiled by feces than the distal end. Another reason for selecting the cord close to the external genitals is the fact that the blood here is not so likely to be clotted. However the injection should not be made too close to the pudendum as it may be necessary to repeat it or the cord may be punctured accidentally by the point of the needle above the place of its introduction. In case the pudendum has not been prepared for labor as in a precipitate delivery the cord may be painted with tincture of iodine or mercuric chrome at the site of the injection.

The umbilical cord vein which gives rise to prominent convolutions on the surface of the cord is easily located (Fig 3 a). The needle attached to the syringe is inserted in a proximal direction into the vein parallel with its course. It is held in place by an artery clamp (Fig 3). If a second puncture should be necessary but usually it is not the first needle is withdrawn and the clamp holding it in position is tightened to prevent the return flow of saline through the puncture opening then the second puncture is made closer to the pudendal orifice (Fig 3 b).

After the needle is in its proper position from 200 to 300 cubic centimeters of warm sterile physiological saline solution is injected slowly into the placenta through the vein. Then the physician waits for uterine contractions and the delivery of the placenta. Sometimes amounts of saline considerably less than 200 cubic centimeters are effective. In the first case I am reporting the placenta was expelled 10 minutes after the introduction of 100 cubic centimeters.

To determine whether the placenta has been detached from the uterus but is remaining in the cervix and vagina one should resort to rectal examination. In that event a mild Crede expression will usually force the placenta out.

At this point it may not be amiss to state that the more general use of rectal examination in obstetric practice should be encouraged especially for physicians doing general work. Many authorities hold that the patient is often potentially infected before labor because she is then examined before her genitals are shaved and cleansed and the physician does not prepare his hands sufficiently for a vaginal examination at that time. During delivery most practitioners are sufficiently careful with their asepsis but many are not equally cautious before the onset of labor.

Once one has become accustomed to the practice the rectal examination is easily performed. For this purpose the physician should carry with him a one finger glove which is inexpensive and requires only boiling, powdering and preservation in a clean dry towel. Such a glove may be used for months without tearing. Figure 4 shows how the glove is slipped over the index finger and outlines the position of the remainder of the hand. By means of the rectal examination one can without loss of much time determine whether the patient is in labor and whether she should be prepared for delivery or allowed to wait for a time.

The physician with a surgical conscience who is strict in his asepsis and unwilling to jeopardize his patient's life for the sake of his own convenience but who is nevertheless pressed for time frequently finds himself in a dilemma. He cannot spare the time necessary for proper preparation for vaginal examination on the other hand if he omits the examination the patient may undergo precipitate labor during his absence in attendance on another patient.

The rectal examination offers the ideal alternative. It is both safe and rapid and also gives the examiner all the necessary information concerning the progress of the labor. It is for this reason that I have taken the space to urge a more general use of rectal examinations in obstetric practice.

REPORT OF CASES

Three cases of adherent placenta in which this organ was expelled in from 10 to 40 minutes after the employment of the Moisan-Gabaston method are here reported. In each case the puerperium was uneventful.

CASE 1. P. S. D. 6 p. w. admitt d t t e
B th D d H p t l J u r y 1 9 4 Th m m b r a
h l r u p t d p t l y b f d m P a l
e m n t d h d t h c r t b d i t t t t t
o f t f i r Th p t t a n r u l y a d s t j d
h d t b s t a d i m n r u n h e v n f n t t o t h
u n a. She had a h u l l n d t h t m p e r t r r o s e t 1 4

degrees F. No fetal heart sound was elicited. When the cervix was sufficiently dilated and the pre-eclamping part was in the mid-pelvis, medium high forceps were applied and a stillborn child delivered. Thirty minutes later the patient began to bleed but not alarmingly. Then an attempt was made to expel the placenta by Credé expression but it was unsuccessful.

After a wait of 1 hour and 10 minutes it was decided that further means would have to be taken to effect the delivery of the placenta. Since the patient had had her fingers inside the vagina on several occasions during labor and consequently the potentialities for infection were very great, I was reluctant to resort to manual extraction and decided to employ the Mojón Gabaston method.

One hundred cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein by means of a 10 cubic centimeter Record syringe. Within 10 minutes the patient had a strong pain and expelled the placenta.

Four hours later the temperature dropped to 100 degrees F. The patient ran a fairly normal postpartum course except that the temperature rose to 101 degrees F. on the third day when the breasts were distended. She was discharged on the tenth day in good condition.

CASE 2. B. S. aged 32, married, admitted to the Beth David Hospital January 15, 1924. There was a normal birth at term. The duration of labor from the first pain to the birth of the child was 5 hours and 35 minutes.

One hour after delivery, mild Credé expression was performed but the placenta was not expelled. A there was no bleeding. I waited 4 hours before invading the uterus then I explored the uterine cavity and found the placenta firmly adherent.

Rather than attempt manual separation, I resorted to the Mojón Gabaston method. Two hundred and fifty cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein after which I waited for another 40 minutes. Then the uterine cavity was explored again but the placenta came out with the mere introduction of the gloved hand. The solution had evidently effected mechanical separation of the placenta so that only the stimulation of the hand was necessary to cause its expulsion.

The patient was discharged with the placenta during her entire stay in the hospital her temperature never rose above 99.5 degrees F.

CASE 3. M. W. aged 2, gravida I, married 2 years, was admitted to Sydenham Hospital April 8, 1927. The membranes had ruptured 10 hours and a half previously. The patient had a long, difficult first stage of labor but was delivered of a girl weighing 7 pounds, 12 ounces, 24 hours after admission. The mother was very obese and heavy and distinctly of the hypothyroid type. She weighed 244 pounds and was 5 feet 4 inches tall.

One hour and a half after the delivery of the child the placenta had not yet been expelled. In a patient so extremely obese manual extraction would have been very difficult since there was very little room in which to work, no matter how widely the thighs were separated. The Mojón Gabaston method was employed.

Eighty cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein. Five minutes later the patient had a pain but the placenta was not ejected. Then 60 cubic centimeters more of the solution were injected and within 10 minutes the patient had two pains and expelled the placenta.

The puerperal course was uneventful and the temperature remained normal throughout this period. The patient was discharged well on the tenth day.

SUMMARY

Various statistics demonstrate that manual removal of the adherent placenta is a dangerous procedure. It has been variously estimated that the mortality is 10 per cent and the morbidity from infection of the uterus 5 per cent following this operation.

The Mojón Gabaston method offers a useful alternative especially in outlying homes where skilled assistants cannot be obtained and sepsis is necessarily imperfect. Essentially this method consists in the injection of 200 to 300 cubic centimeters of warm sterile normal saline solution into the placenta through the umbilical cord vein. This solution distends the placenta and ruptures the small vessels connecting it with the placental site of the uterus, thus forming a retroplacental hydroma, the mechanical action of which produces separation and expulsion of the placenta.

The great majority of workers who have used the Mojón Gabaston method report results superior to those following manual extraction. In the three cases reported by me the placenta was delivered in from 10 to 40 minutes and the course of the puerperium was uneventful.

The following points with regard to the application of the Mojón Gabaston method deserve special mention:

1. The procedure is simple, requiring only a few saline tablets for the solution and a Record or Luer syringe.

2. No anesthetist is required as for manual extraction.

3. It is not necessary to scrub or change gloves.

4. Since the injection is made into the unsoiled portion of the protruding umbilical cord, there is no danger of carrying infection.

5. In placenta accreta, there is a possible chance of securing separation by the Mojón Gabaston method or by this procedure in conjunction with Credé expression. Furthermore, even if the injection of the saline does not prove effective, it facilitates the subsequent manual removal of the placenta.

6. In precipitate labor when there has been no time to prepare the external genitalia properly, manual extraction is hazardous because of the great likelihood of subsequent infection. In such cases the Mojón Gabaston procedure is much to be preferred.

7. The site of the injection may be touched with tincture of iodine or mercurochrome. The bladder should always be emptied before the injection.

8 In none of my three cases were there any untoward results

9 It is very useful in febrile and infected patients

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THE ESTIMATION OF PERMANENT FUNCTIONAL DISABILITY
FOLLOWING FRACTURES

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AT the present time every physician in active practice is called upon frequently almost daily to examine and treat patients who have been injured in industrial occupations the majority of injuries occurring under such circumstances comes directly within the scope of workmen's compensation legislation. Among such injuries fractures of bones assume a position of great importance because some degree of permanent disability is a very frequent sequel. To call attention to the principal factors which may aid in forming an opinion as to the degree of this disability is the object of this paper.

Many injuries while severe cause only temporary disability. That is to say, when healing has taken place the cure is complete and the workman so far as he or anyone else is able to discover and so far as his working capacity goes is as good as he was previous to his injury. The time required to effect the cure may vary from a few days to several months or even longer the disability may be very slight or only partial or it may be complete while it lasts regardless of all this the essential feature of such disability is that it is *temporary*. In all such cases after the treatment has been successful the only question remaining for the surgeon to decide is as to the length of the period of disability in other words upon what date did the healing period end and when was full functional capacity re-established? This period of time determines the amount of compensation which in these cases indemnifies only for the time lost from work. As a rule the answer to the above question is fairly easily given.

When however as is unfortunately often the case the injury owing to its nature determines a *permanent disability* or reduction in functional capacity the problem confronting the surgeon is not so simple. This disability may be complete or partial in the latter case it becomes the duty of the surgeon to estimate the degree. While it is true that most of the various state compensation acts contain specific schedules of indemnities for certain definite injuries such as amputations etc. it is obviously impossible that these could cover the whole field. It is also true that frequently these specific schedules represent mere arbitrary values which have been assigned to certain specified disabilities such values may or may not

express a true estimate. Be that as it may we are not here concerned with definite specific disabilities or mutilations for which definite indemnities are provided by law. But it is apparent that the range of possible disabilities is entirely too great too many unknown factors enter into the healing of wounds each patient is too individual in his reaction to injury for any law to be framed which could assign a specific indemnity to every injury. Hence every case not covered by a specific indemnity in a law must be examined carefully and an evaluation of the existing permanent disability made as a result of such examination.

Disability or loss of function may be viewed under several different aspects. In the first place we may have an *anatomical* disability. In these cases there is an actual loss of some portion of the organism as in an amputation of a leg. The disability may be *functional* that is although the disabled part has not been removed and still forms an integral part of the organism it is wholly or partially useless. As examples of this may be mentioned an extremity paralyzed as a result of a fracture of the spine or severance of a peripheral nerve vicious union in a fracture etc. Finally the disability may be *professional* in the latter case the injured man may be completely unable to perform the work which he did previous to his accident and yet be entirely capable of doing something else.

The degree of functional impairment or disability is expressed in percentage. Under the laws of most European countries the normal healthy organism as a whole is considered as representing 100 estimations as to the degree of impairment resulting from the loss of several fingers a hand vicious union in a fracture etc. are made with this as a standard. Under most of our state laws however specific values are assigned to the various parts of the extremities which leads to evaluation frequently upon a different basis. For example a clumant may present himself with a stiff almost useless wrist the result of a fracture at the lower end of the radius. The arm above the elbow is entirely normal. Under many of our laws the arm from the elbow down would represent 100 and the estimate of functional loss made upon this basis. Naturally however many conditions arise in which the functional capacity

of the body as a whole must be taken as the standard for comparison

To estimate disability with any degree of exactitude requires a thorough examination sound judgment experience and common sense. The examiner must likewise preserve a thoroughly judicial attitude. Previous to the advent of compensation legislation which is a matter of recent years surgeons were rarely called upon to express an opinion in exact figures as to the degree of disability in any given case today it is a matter of daily occurrence. In the beginning with no previous experience to serve as a guide these opinions often represented mere guesses today however by taking into consideration certain factors which have been found to be important and by considering a case in all its aspects an examiner can arrive at a figure which seems to be approximately correct for practical purposes that such is the case is demonstrated by the fact that any number of independent experienced examiners in reference to a given case will arrive at very nearly the same figure with but slight variation one way or the other.

If the estimation of disability follows on a jury could be reduced to a strictly mathematical basis the problem would be comparatively simple several attempts have been made with this object in view but they all leave much to be desired.

Moorhead¹ suggested a standard of end result values based on the three factors of function union and contour. To function he arbitrarily assigned a value of 60 per cent to union or healing a value of 20 per cent and to contour or cosmetic result a value of 20 per cent. Several objections may be urged against this method. The principal one is however that the most important element in the above formula function which must be known before the formula can be applied is the one which we are most interested in determining. And function cannot be determined without taking into consideration union or healing which forms the second factor in the formula. Consequently we are just as far from a mathematical basis as ever for the estimation of function still remains a matter of personal judgment and experience even though we wish to make use of this suggested plan. Even though this were not true in my opinion the value assigned to contour or cosmetic result is altogether too high.

The method of Kessler makes use of factors which are capable of measurement with some

Kessler's method of measurement with some

degree of accuracy it is true. The factors are (1) joint movement (2) muscular power and (3) co-ordination and brain control. But having obtained the measurements the problem of applying them so as to determine correctly the loss of function in a limb as a whole still remains. By assigning certain arbitrary values to the various joints and parts of an extremity a definite figure may be obtained but again the personal factor has entered and in my opinion the results are no more accurate than those obtained by a simple estimation based upon a careful consideration of all those factors present which go to make up the disability. In fact in certain cases the figures arrived at by Kessler's method will be entirely too high. Certain other reasonable objections to it may also be advanced but a full discussion of the method does not come within the scope of this paper.

So far as I know no method has been devised up to the present time into which the personal element does not enter. Consequently none of them give figures which we can be sure are absolutely reliable in the last analysis. Under such circumstances I believe that an opinion based upon thorough examination good judgment common sense and experience is just as valuable as one based upon the application of any arbitrary formula.

As was said previously fractures constitute one of the most frequent of the serious industrial injuries which the general surgeon is called upon to treat they are likewise one of the most frequent causes of permanent disability thus giving rise to circumstances in which estimates of the degree of impairment are required. While I do not believe as stated above that the estimation of disabilities even approaches an exact science in a very remote degree or that it ever will or that there are definite rules by which correct figures may be arrived at nevertheless there are certain conditions common to all fractures the presence or absence of which must be established by examinations with this object in view when this has been done definite information is obtained upon the basis of which if sanely interpreted a reasonably correct estimate can be made.

The evolution of a typical fracture for example one of the extremities may be considered to occupy four stages. The first stage follows immediately after the accident. It is usually short but for various reasons may be prolonged for several days. The fracture is recent shock if present must be combatted the patient may have to be transported some distance enormous

hæmorrhage into the tissues may prevent immediate reduction. Under these circumstances any retentive apparatus is merely temporary.

The second stage is that of active treatment. The fracture is now reduced and reduction maintained with suitable permanent retentive apparatus. Open operation if indicated is performed. If the fracture is an open one efforts are made to prevent infection or to treat it if present. The aim of treatment during this stage is to secure as perfect anatomical repair as is possible.

The third stage is the stage of functional convalescence. Bony union is now well advanced and treatment is aimed at promoting the rapid return of normal function.

The fourth stage is that of useful convalescence. In this stage the patient returns to work. Such work is usually light in the beginning, becoming more arduous and heavy as the injured member recovers its capacity for performing its normal functions in connection with the usual occupation of the claimant. Under the best of circumstances this recovery is ultimately complete. Ordinarily it happens that a certain degree of permanent incapacity remains.

It is thus to be seen that the aims of treatment in any fracture are twofold: first, in the beginning, anatomical repair as perfect as possible is to be sought for without however at any time losing sight of the second, which is functional restoration. From the point of view of workmen's compensation the latter is the more important. It is also clearly obvious that any estimate of impairment of function or disability to be of any value must be based upon conditions either actual or anticipated at the end of the fourth stage above or when no further improvement is to be expected.

When a fracture is examined the question to be decided is: To what extent if any has the functional or working capacity of the limb been impaired as a result of this fracture? To answer this the examination must be conducted with a view to obtaining all the information possible upon the following points: (1) the condition of the fracture itself; (2) the condition of neighboring and adjacent structures; (3) the effect of each of these upon the other; (4) the effect of all these above factors taken collectively upon the functional efficiency of the member as a whole.

The fourth point cannot be too strongly emphasized. There may be multiple disabilities but each one cannot be estimated separately, what is desired is the functional disability of the limb or portion of a limb taken as a whole and

not the various disabilities of its muscles, nerves, tendons, etc., though naturally these must have been considered before arriving at the final estimate.

Another factor that of adaptation undoubtedly plays an extremely important part in reducing the ultimate disability from any injury, whether fracture or not. Compensation laws however as a rule do not take it into account; consequently it has been excluded from consideration in this discussion. Its influence is extremely uncertain and hard to evaluate, the power of adaptation varying so greatly in different individuals, however there is absolutely no doubt that were it reckoned with our present estimates would be found to be too high.

Turning now to a consideration of the condition of the fracture itself, it is of extreme importance in the first place to determine its exact location in the bone. Perfect coaptation of fragments is much easier to secure in some sites than in others, for example, as a rule a better functional result is secured in fractures of the shaft of a bone than in intra-articular and juxta-articular fractures. In these latter situations perfect coaptation is often hard to obtain while at the same time it is of more importance than in fractures of the shaft. In addition to this there is always more or less exudate and hæmorrhage into the joint, the period of immobilization necessary for union of the fragments greatly hinders absorption of this exudate and adhesions will be formed which will give rise to functional disability. Naturally the early employment of passive motion and massage in the treatment of such fractures will greatly minimize the danger of a stiff joint, nevertheless stiffness and disability sometimes remain after the best possible care, and are the rule in fracture treated by prolonged immobilization as is still frequently the case. Disability in juxta-articular fractures may be the result of exuberant callus leading to a limitation of joint motion.

In fractures of the shafts of certain bones nerves may be injured and it is important that the examination be made with this possibility in mind. Thus in fractures at the upper end of the humerus the circumflex nerve may be implicated in the middle of the shaft the musculospiral. A fracture at the upper end of the fibula may involve the peroneal.

In the forearm exuberant callus following fracture of one of the bones may be the cause of great functional disability by preventing rotation of the radius about the ulna.

From the brief considerations it is clear that the site of the fracture is an important factor in

estimating the resulting disability. But this is only one of them.

The alinement of the fragments may be poor there may be incomplete apposition or overriding union with angular deviation of the fragments may have taken place the so-called vicious union shortening may be present vicious callus non union pseudarthrosis all these present themselves as possible elements in evaluation.

When either delayed union or non union is present no correct estimate of the permanent disability can be made and one should not be attempted. Both conditions simply mean that the evolution of the fracture is not yet complete consequently the final examination of the case should be postponed until a later date when no further change is to be expected.

A careful differentiation must be made between non union and pseudarthrosis however. Most cases of the former are readily amenable to surgical treatment with ultimate bony union such may or may not be true in the latter condition. When the time of consolidation of a fracture is prolonged beyond the time usual for such a fracture the case is considered as one of delayed union when the period of time has been much prolonged and consolidation has not taken place it becomes one of non union. Such cases must be investigated very carefully. The interposition of a strip of muscle or fascia between the fractured end of a bone may delay union indefinitely causing the case to be considered one of pseudarthrosis with removal of the cause for delay however union may promptly occur. Local or constitutional condition which may give rise to non union must be kept in mind and searched for and their absence established before a diagnosis of pseudarthrosis can be made. Pseudarthrosis is very frequent in case with extensive loss of bony substance as in gunshot wound compound comminuted fractures etc. On the other hand severe infection may indefinitely delay union. Clinically in pseudarthrosis the affected part presents a high degree of abnormal mobility while pain is entirely absent edema and swelling are usually absent and the skin is more or less normal in appearance. In delayed or non union on the other hand the abnormal mobility is much less pronounced some pain is always present the soft parts are swollen and edematous and the skin frequently presents a bluish or cyanotic appearance with often trophic changes. Skiagrams likewise usually show some evidence of callus formation in cases of non union in cases of pseudarthrosis no callus is present and the

ends of the fragments are more or less rounded off.

What effect has an existing pseudarthrosis upon the functional efficiency of the affected limb? Naturally under the best of circumstances the disability is considerable the degree however varies somewhat with the situation of the false joint and with the condition of the surrounding structures. The principal consequence of a pseudarthrosis is an insufficient rigidity of the affected part. In the humerus often to a surprising extent this may be overcome during purposeful movements by powerful muscular contraction holding the ends of the fragments together frequently a satisfactory brace may be fitted. Pseudarthrosis is of both bones of the forearm is extremely disabling and may at times be equivalent to total functional loss of the member if it involves but one bone the results may or may not be serious. In regard to the radius if the power of pronation and supination is lost the disability is great if there is likewise associated outward deviation of the hand due to injury in the neighborhood of the radial epiphysis the disability is still greater. Under such circumstances the grip of the fingers is extremely weak. Pseudarthrosis in the ulna is much less disabling.

When we consider the lower extremity we find that pseudarthroses here are of much greater consequence. The principal quality of the leg is solidity and no amount of muscular contraction can furnish sufficient solidity for weight bearing apparatus likewise while of some assistance nevertheless leaves much to be desired. Pseudarthrosis of the femur and tibia may at times be sufficiently disabling as to require amputation of the leg fortunately the former is rare. Pseudarthrosis of the fibula alone however may be present with very little diminution in the function of the leg provided that the external malleolus is intact otherwise there will be marked outward deviation of the foot with consequent increase in disability.

In all cases of pseudarthrosis the condition of associated structure in the limb is of the utmost importance interference with nerve or muscle function naturally greatly augments the degree of disability.

Union of a fracture may occur with the fragments in such a defective position that the functions of a part are seriously interfered with. Such may be the result of angulation overriding or some other variety of incomplete reduction. It may also be the result of too early resumption of functional activity before sufficient bone has

formed in the callus. The effects of vicious union are as a rule least marked in the humerus. Here unless nerve function is interfered with or shortening is extreme, considerable degrees of deformity are entirely compatible with perfect or almost perfect function of the arm. Such is not the case in the forearm. Angular deviation of either bone may seriously interfere with, if not entirely abolish, the movements of pronation and supination. In addition, if pronounced deviation of the hand to the affected side may be produced, leading to weakening of the grip and serious disability. Angular deviation of both bones may give rise to an impairment of function amounting practically in extreme cases to complete loss of the hand. Deformity at the lower end of the radius gives rise to a high degree of disability, by interfering with the movements of flexion and extension at the wrist. If this is associated with tendon adhesions, stiffness of the fingers, etc., as is so often the case, the disability reaches an extreme grade and the hand is practically useless.

Vicious union occurring in the lower extremity may likewise have serious consequences. Shortening, which is ordinarily of least importance, will be discussed later. Angular deviation, however, unless extremely slight, cannot fail to cause some disturbance of the axis of weight bearing. In the leg and foot, the arrangement of the bones, their mutual relationships, the strength of ligaments, the direction of muscular pull, in fact, the entire structure has been developed for the purpose of supporting the weight of the body and for locomotion under normal conditions and can only function at maximum efficiency when the line of weight bearing falls in its normal axis. Any deviation in this normal axis sets up numerous abnormal strains and stresses in the entire extremity, including frequently the pelvis and spinal column. Such a condition cannot but be productive of more or less marked loss of functional efficiency. In the milder grades, this may be manifested only as pain resulting from tired and over-stretched muscles and ligaments. Upon the resumption of activity after a period of rest, such pain may not immediately make itself felt, but after a varying period of use it comes on and persists, constituting a marked disability in a man whose work compels him to be constantly on his feet. In all such cases, the various forces present in the extremity, while it is in use, should be carefully investigated. While pain, being a purely subjective manifestation, is undoubtedly often simulated and more frequently exaggerated, nevertheless in many of these cases a careful study will often reveal a physical basis for it.

Marked angulation of the femur, fractures in the neighborhood of the knee and ankle joints with union of fragments in poor position, particularly fractures of one or both malleoli, fractures of the tibial shaft, fractures of the os calcis or astragalus, fractures of the metatarsals—all these various forms of fracture giving rise to static disturbances or by mechanical interference with the functions of joints, may occasion disabilities which are usually considerable and which may occasionally be equivalent to practical loss of the member.

Fortunately, many of these conditions are to day amenable to surgical treatment, such being the case, no estimate of permanent disability should be made in these cases until it is certain that no further improvement in the condition present can be hoped for from expert surgical procedure.

Another factor in evaluation which must be considered is shortening. As stated above, it has not an importance of the first order. It is due to angulation overriding impaction or extensive loss of substance, such as occurs in osteomyelitis or gunshot wounds. It is usually not marked, although occasionally it may be enormous, under which circumstances it becomes a consideration of prime importance. In the humerus, it need enter but little into our estimate. In the forearm, much loss of substance of one bone presents an absolute obstacle to union in that bone and we have developed a pseudarthrosis. Under certain circumstances, union with shortening of one bone may give rise to deviation of the hand to one side or the other, thus occasioning permanent disability. Shortening of both bones of the forearm, as a rule, is due to union with overriding of the fragments; in such a case, the disability present is the result of factors other than the shortening, such as loss of pronation and supination, tendon adhesions, nerve pressure, etc.

In the lower extremity, shortening of 3 to 4 centimeters is usually readily compensated for by tilting the pelvis and does not constitute a disability, as a matter of fact, there is frequently a normal variation present in the length of the two legs. Above 4 cm., the injured person limps more or less, but with a solid extremity, good alignment and vigorous muscular development, claudication does not constitute a very serious disability for the average workman. Naturally, with extreme degrees of shortening, the disability is correspondingly greater.

Abnormalities of the callus following a fracture are not infrequently the cause of permanent disability. The callus may be painful from

inclusion in it of nerve fibers or frequently for no reason at all that we are able to ascertain. And this painful condition may not respond to any treatment. The callus may be too large either from overproduction in the first place or from failure of absorption—persistent callus. Infection is an important element in causing overproduction. When too large the callus may interfere with the normal action of muscles and tendons occasion difficulty in wearing shoes and sometimes give rise to ulcerations of the overlying skin. Nerves may be included in it with abolition of their function and peripheral paralysis. In the fore arm it may interfere with the normal movement of one bone on the other and not infrequently leads to a fusion of the two bones.

Chronic suppuration due to osteomyelitis is not a direct factor in the evaluation of permanent disability when such a condition is present it represents but one stage in the evolution of the fracture. Under such circumstances no estimate can be made with any degree of exactness and none should be attempted. The final examination and assessment should be postponed until such time when no further treatment of any kind is indicated and no further change in the condition of the injured member is to be expected.

All of these various pathological conditions which have just been described arise directly from and are intimately connected with the healing of the fracture itself. Any or all of them are capable of producing varying degrees of permanent disability consequently in any given case the effects of the presence of one or several of them their degree of severity etc. all must be taken into consideration in the final estimate of loss of function. But having done this the list of factors giving rise to permanent disability is not yet complete. There still remain for discussion pathological conditions giving rise to disability arising as a result of a fracture but affecting tissues and structures other than the bone itself such as nerves muscles joints and circulatory channels.

Disturbances of nerve function may be manifested either subjectively or objectively.

The principal if not the only subjective manifestation is pain. A certain amount of pain and soreness is so frequent following fractures that it may almost be said to be a constant finding. As a rule however it rapidly disappears following resumption of normal activity to recur perhaps to some slight extent during damp or changeable weather. Such pain may constitute an inconvenience it is true but it is not a disability. On the other hand cases are often seen in which the

pain is very severe and may persist for years. Under these circumstances a real disability is produced. Such pain is often due to nerve compression by callus or to the inclusion of nerve fibers in a healed scar or to factors of which we are ignorant at any rate no definite cause for it can be discovered. As a rule pain in the lower extremity gives rise to more disability than pain in the upper. In all cases of alleged disability from pain extreme care must be taken not to assign to it undue importance. Pain is easily simulated and there is no standard by which it may be appreciated also there is an unconscious tendency common to practically all human beings to exaggerate it in evaluating pain therefore these things should be taken into account. On the other hand it should never be lost sight of that severe persistent pain is not infrequently present particularly following fractures of the leg and that definite sometimes marked disability may result from it.

From an objective standpoint we may have definite paralysis as a result of nerve injuries. When present these are a very important factor in the determination of disabilities. Disturbance of nerve function may be the result of direct injury at the time of the fracture or may occur secondarily from pressure by or involvement of the nerve in the callus. Minor degrees of functional nerve disturbance are frequently present and are manifested by trophic disturbances cutaneous anesthesia etc. The delicate glossy condition of the skin of the hand and fingers which is so commonly observed after fractures of the forearm and wrist is undoubtedly due to interference with nerve function. Assessment in cases of severe nerve injury often presents a difficult problem on account of the uncertain prognosis it may not infrequently be necessary to allow several months to elapse to allow for possible regeneration before undertaking a final estimate. Many cases are amenable to surgical treatment while others are not. In view of all this extremely careful and painstaking study of all case showing nerve involvement is necessary.

Closely associated with nerve injury is muscular atrophy. To some extent it is constantly present following every fracture. While disuse from prolonged immobilization is commonly assigned as a cause for it in the absence of definite nerve injury it may well be that certain other factors are also active in every case. The chief of these is the so called trophic disturbance due probably to obscure disturbances of nerve function but which are not due to direct trauma from the

fracture or to any of the other conditions mentioned above as causing nerve injury. Whatever the cause the degree of muscular atrophy must always be taken into account in estimating disability.

To determine the degree of atrophy comparative mensuration is ordinarily employed and furnishes sufficient information for our purpose. But in taking the measurements care must be exercised and the sources of error and fallacies of the method kept clearly in mind. For example the thigh being conical is difficult to measure correctly unless care is taken to have both legs in the same position and equally relaxed and unless the measurements are taken at exactly corresponding points on each extremity. On the other hand the calf is much easier to measure because it presents an easily accessible maximum circumference the same is true of the upper arm while the forearm again presents the same difficulty as the thigh. Assuming that correct measurements have been taken however caution must still be exercised in drawing conclusions muscular development is frequently asymmetric. The right arm is normally larger in right handed individuals as is well known and the reverse is true of those who are left handed. The calves of the legs are often unequal in size and it is sometimes the right sometimes the left which is larger finally certain occupations may give rise to work hypertrophy of muscles which are normally not overdeveloped in the average individual. Overriding of fragments and oedema may also add to the uncertainty. Fortunately much assistance may be gained from palpation in a normal individual the muscular masses while they may be unequal in volume are equal in consistence softness and flabbiness certainly indicate atrophy and the sensation furnished by such muscles is almost characteristic. In certain cases particularly those in which atrophy is extensive electrical testing of the affected muscles is often of value.

The condition of the neighboring articulations following a fracture must always be a subject of careful investigation. Complete ankylosis while it does occur is fortunately rare partial ankylosis is more common and varying degrees of stiffness are present in practically every case unless the conditions of treatment have been ideal. All of the minor forms of joint disturbance and some of the more severe ones are usually due to prolonged immobilization others particularly the graver types result from the relation of the fracture to the joint giving rise to injuries of articular cartilages imperfect reduction of fragments

constituting actual mechanical hindrance to joint motion etc. Limitation of joint motion may also result from scar contraction following compound fractures. Finally all of the periaricular structures may be the seat of a pathological process giving rise to a condition of so called chronic arthropathy. The stiff and painful shoulder so frequently seen following trauma to this joint particularly in middle aged and elderly patients is a typical example of such a condition. Unless carefully treated with early massage and passive motion fractures in the neighborhood of the wrist joint are particularly liable to leave the wrist and hand disabled since the intimately associated flexor and extensor tendons share largely in the pathological process.

In cases of complete ankylosis the degree of disability depends first upon the decrease of functional efficiency due to loss of motion in the joint and second which is the most important factor upon the angle of fixation. The latter may determine the question as to whether the functional loss is 10 per cent or 100 per cent. In cases of partial ankylosis the arc of mobility retained whether favorable or unfavorable is the deciding factor.

All cases of limitation of motion and of partial ankylosis are benefited by the resumption of normal activity so far as possible consequently no final estimate can be made before use of the extremity has been undertaken and no further improvement is manifest. It is often astonishing to what a degree limitation of motion will disappear naturally such is not the case if the limitation is due to a mechanical obstacle.

Circulatory disturbances are frequently seen after fractures. After removal of a cast the extremity commonly becomes somewhat cyanotic and oedematous for a time particularly the leg with use however in most cases this rapidly disappears. But we sometimes see cases in which it persists. Under such circumstances it may be due to phlebitis or to other factors the nature of which is obscure. Occasionally this oedema becomes hard and firm and very painful the prognosis here is bad the condition is more or less permanent it gives rise to considerable impairment of function and must be considered an important factor in estimating permanent disability.

These diverse variations from the normal which have just been discussed the concomitant complications and sequelæ of fractures represent the positive elements which must be considered in estimating the degree of functional loss. Disability is conditioned by them. It seems self

evident in general that the more closely the final result following fractures approaches the anatomical normal the better the functional result. The question is summed up briefly and excellently by Llewellyn and Jones as follows:

1. A close interdependence obtains between the character of the anatomical union and the ultimate functional results.

2. In a simple fracture given good alignment, sound union, and the absence of complications, such is generally correlated with excellent functional results in 90 per cent of cases.

3. With faulty alignment the ultimate functional efficiency of the limb is usually impaired and this in general in direct ratio to the mechanical imperfections thereof.

So far I have attempted in this paper to discuss only those more or less definite tangible and principally physical conditions associated with fractures, the effects of which on the ultimate functional efficiency of the part are susceptible of measurement or estimation with an approximate degree of accuracy. Other factors are undoubtedly present to some extent in every case and influence the ultimate result, but their effects vary so much in each individual and are in general so intangible that as a rule they must be disregarded in estimating disability. A few examples may make this clearer.

The psychic attitude of the patient plays an undeniable rôle in his complete recovery. I am not here referring to cases of simulation or malingering or to the traumatic neuroses. But some cases seem to lack confidence in themselves and are unable to make a proper effort to recover function, even when the physical impairment is relatively slight, and this is true in cases where no compensation is expected.

Another factor is the personal coefficient of

skill. We not infrequently see patients who have regained functional use of a member to a surprising degree in spite of what is apparently an extremely grave physical handicap. On the other hand, patients are seen in whom the return of function is far from being what we should expect and this in spite of their best efforts.

Closely related to the factor last mentioned is that of adaptation or accommodation of the individual to the changed conditions following his fracture, which was briefly mentioned above. This undoubtedly plays a large rôle in every case, nevertheless the degree to which it will bring about improvement cannot be anticipated nor estimated.

The age of the claimant is also of importance. Recovery from fractures in those past middle life is undoubtedly slower and less complete as a rule, but even this is subject to individual variations.

In all cases it must be clear that no opinion can be based on anatomical findings alone. While in general, as was stated above, anatomical and functional results are usually closely interdependent, yet this does not hold true in every case and it is upon the basis of functional efficiency that we must base our estimate. In all cases we cannot confine our examination to the fracture alone and base our opinion upon its condition; the condition of all the parts of the affected member must be taken into consideration. If the lesions are multiple, also we cannot evaluate them separately, assigning a certain percentage to the fracture, another percentage to loss of motion in a joint, etc. The sum of figures obtained in this way does not represent the actual disability present, but it is not infrequent to see an attempt made to arrive at it in this way. In every case the estimate is to be made of the loss of function of the limb as a whole and not upon that of its various parts.

$$\frac{P_{ns}}{d_j} \times \frac{d_h}{St} \times \frac{P_{nc}}{C} \times \frac{P_l}{V} \times \frac{f_{Th}}{by} \times \frac{E}{g} \times \frac{l}{p} \times \frac{t}{363} \times By \times Ll \times lly$$

SPINAL ANÆSTHESIA

By C. B. SCHUTZ, M.D., PHILADELPHIA

L. K. na H. p. tal

IT is obviously true that the ideal anæsthesia is local anæsthesia and it is equally true and obvious that the ideal local anæsthetic has not as yet been found. When it is found half of our surgical worries will be dispelled. At present we have at our command many different methods of administering local anæsthesia and many different agents for its use. Most of them are acceptable but no one of them is entirely satisfactory. Spinal anæsthesia we believe has its place in this group and in selected cases according to our present standards of comparison is as nearly satisfactory as any of the available methods. As in most innovations in surgery each has its loyal advocate—a loyalty that in some instances proves dangerous because of its blindness. In the Lankenau Clinic we began the use of spinal anæsthesia with the hope of giving the patient the benefit of its avowed advantages. We have continued its use for over years with a realization of its dangers and its disadvantages but with a recognition of its distinct advantages. It is the purpose of this paper to present the facts of spinal anæsthesia as we have learned them from our experience of over 1000 cases. Though we have used stovaine, novocain, and scurocaine our largest experience has been with apothesine and it is this drug that has been used in all of the cases with which this report is concerned.

Spinal anæsthesia has been so widely used that it would seem trite to speak of its advantages and its indications were it not for the fact that one is so frequently questioned as to whether or not it is an anæsthetic of sufficient merit, safety, and advantage over general anæsthesia to justify its use. We are of the decided opinion that spinal anæsthesia is the anæsthetic of choice in selected cases with the emphasis on selected cases. Just what types of cases we consider as belonging to these selected cases will be discussed below.

Apothesine produces a paralysis of the sensory and motor nerves involved in the area of an anæsthesia. It is essentially a peripheral nerve paralysis and has certain distinct advantages over general anæsthesia. It abolishes pain but unlike general anæsthesia the pain is abolished by producing a peripheral bloc to sensory stimuli thus giving true anoci association. This may be a factor in the lessened amount of shock shown by patients so anæsthetized. Its greatest advantage

however and one of sufficient merit to justify its use is the perfect relaxation which it produces. The relaxation is almost cadaveric and thus allows the operator to proceed with the minimum of technical difficulty—a distinct advantage to the patient as well as to the surgeon no matter how skilled the latter may be. For example we attribute our low mortality of per cent in acute appendicitis partly to the fact that this form of anæsthesia is used in so many of these cases for it allows good exposure with delicate retraction. As the effect of the anæsthesia subsides this relaxation disappears but its duration is sufficient to permit almost any abdominal operation. Its efficient effects sometimes last from 45 minutes to an hour—although it is seldom satisfactory for a longer period.

The safety of this form of anæsthesia has in our experience been absolute. We have never had a mortality which could be attributed directly to the anæsthetic and we have never seen a single sequelæ which has warranted anything more than transitory concern. We do not however consider it harmless. Every case in which this anæsthesia is administered is carefully selected, carefully watched, and the dose of the drug is carefully calculated and carefully given. It speaks well for the safety of the anæsthetic when we state that in this clinic the interne who administers it is changed every three months and except for practice on the cadaver and by observing others has had no previous experience.

INDICATIONS

There are certain types of cases which to our mind demand spinal anæsthesia, others in which it may be indicated and still others in which it is definitely contra-indicated. In the past years our postoperative pneumonia mortality has been reduced to a very low figure and although there are other factors involved such as pre-operative treatment and the comparative exclusion of ether anæsthesia we attribute a large part of this to our practice of using spinal anæsthesia in all cases having pulmonary symptoms in which there is no definite contra-indication to spinal anæsthesia. Practically every case of intestinal obstruction is operated upon under this anæsthesia. In this type of case the technical difficulties are reduced to their lowest degree by the complete

relaxation produced by the anæsthesia. Further more the tendency of the dilated intestines to fall away from the anterior abdominal wall practically abolishes the usual difficulty in replacing the eviscerated intestines and aids in decreasing the amount of shock following this operation. The technical difficulties which are to be expected in cases of large abdominal tumors secondary operation where the viscera are bound up by adhesions thick abdominal walls and especially in difficult kidney operations almost invariably disappear when spinal anæsthesia is used. Abdominal pus cases demand spinal anæsthesia even when the blood pressure is lower than the accepted minimum in other types of cases. Here absolute relaxation is not only convenient to the surgeon but it is of vital importance to the patient. Every added traumatism used in obtaining the necessary exposure vastly increases the danger of spreading pus which nature has taken so much trouble to localize and wall off. This cannot be overemphasized for to get good results in these cases one must handle the tissues lovingly and this is well nigh impossible under gas anæsthesia and often difficult under ether.

There are certain cases in which operation can be done with comparative ease under gas or ether anæsthesia but better results are had if operation is done under spinal anæsthesia. These cases include those in which there is evidence of renal insufficiency or dysfunction as shown by a high blood urea, albumin and casts in the urine. It is of course well known that ether causes destruction of renal tissue and that traces of albumin and casts may be found in the postoperative urine of patients who have been operated under gas anæsthesia. This renal change following gas or ether in the usual case is of little moment but when there is already some kidney deficiency before operation it becomes of greater importance. Our experience has been that cases with blood ureas above normal or showing other evidence of renal upset such as albumin casts etc. in the urine are much less harmed by an operation under spinal than under any form of general anæsthesia. Cases with high blood pressure present a difficult problem for any operation and for any anæsthesia. We are not particularly enthusiastic about spinal anæsthesia in these cases but we do not hesitate in fact we prefer to use it if there is no decided evidence of cardiac weakness. We have found that these patients do as well if not better with it than with ether and certainly better than with gas.

Spinal anæsthesia is given not only in the difficult cases but in those in which a prolonged surgical procedure is necessary. They practically always do better than when a general anæsthetic is given because postoperative shock is reduced. The fact that the spinal anæsthesia usually wears off before the operation is completed offers no objection to its use for as the anæsthetic begins to lose its effect gas and oxygen may be given and the operation completed without discomfort to the patient or to the surgeon.

The one definite contra indication to spinal anæsthesia is a low systolic blood pressure. The accepted safe minimum systolic blood pressure is usually given as 100 but we have frequently used spinal anæsthesia in cases in which the systolic blood pressure was between 90 and 95 and have not seen any particular tendency toward more pronounced immediate untoward symptoms of the anæsthesia than in the usual case. It is however safer for the inexperienced surgeon to consider a systolic pressure of 100 millimeters as a minimum of safety. It is not always possible to judge how great a fall in systolic pressure will follow the anæsthesia and it requires some experience to calculate the proper dosage and to estimate the proper amount of pressure used in the injection of the drug. It is well to remember also that it is the systolic blood pressure at the time of operation that is of importance. A blood pressure estimate taken days or weeks before operation cannot serve as a criterion.

There can be no doubt that the anæsthesia puts a strain upon the heart for the sudden fall in blood pressure requires an active and efficient compensatory cardiovascular system. As there is somewhat more strain under this anæsthesia than under gas or ether we seldom give spinal anæsthesia where there is evidence of low cardiac reserve. For some time we have felt and are now convinced that the highly nervous apprehensive patient is not a suitable subject for this form of anæsthesia if it is used alone. The mental chaos that these patients make for themselves offsets many of the good effects of the anæsthetic. However in this type of patient spinal anæsthesia in conjunction with a very light gas anæsthesia approaches the ideal. The combination provides perfect relaxation complete sensory paralysis in the operative field with just sufficient general anæsthesia to paralyze the frontal lobes. At the completion of the operation a few inhalations of oxygen restore consciousness and relieve the patient of the distressing experience of coming out of the general anæsthesia. Furthermore liquids can be taken by mouth much sooner than

after general anæsthesia—trifles which often rise to importance in this type of patient

In the aged and in the young patient the anæsthesia must be given with care. We have never given it to a patient younger than 14 years. We frequently give it to patients beyond 80 years of age but we are always guided by the general condition of the individual and invariably proceed with caution. In the very old patient we use it most frequently for amputations of the lower extremity for such conditions as senile gangrene. In these patients the minimum dose often suffices and whether or not the reduction of the postoperative shock should be ascribed to anæsthesia depends upon one's opinion of the theory. In some of these patients the presence of an old osteo arthritis involving the lumbar vertebrae offers difficulty in making a clean and smooth spinal puncture and it is therefore occasionally difficult to obtain a good take. But the presence of this sequela of arthritis is not in itself a contra indication to spinal anæsthesia. In prostatic bladder and uterine operations in operations on the sigmoid and in carcinomatous cases in which extensive bowel resection is required this form of anæsthesia with the exception already referred to is the one of choice.

TYPE OF DRUG USED

As before stated our experience has been largest in the use of apothesine. We have upon occasions used stovaine, novocain and scurocaine but have always returned to apothesine as a more favorable drug. We realize that novocain is more widely used than apothesine and with good results and therefore must conclude that novocain and apothesine are about equally efficient. It is not the purpose of this paper to advocate apothesine in favor of novocain but merely to record our experience with the latter drug. We have discarded stovaine because it is too toxic to be used with safety. Scurocaine has the advantage over apothesine in that it does not require the withdrawal of spinal fluid and that it can be used above the umbilical line but it has the disadvantage for lower abdominal surgery in that two injections are required.

Apothesine presents two immediate untoward results. The first and the more serious is a fall in the systolic blood pressure with slow, shallow respirations and a weakened pulse. To the inexperienced operator these may sometimes be alarming but we have never found them unmanageable. The fall in the systolic pressure which rarely is as great as twenty points is due to the direct effect of the drug in causing a paralysis of

the splanchnic nerves—including the vaso constrictors in this region with a consequent pooling of the blood in the splanchnic vessels. This is produced with such rapidity that the remaining portion of the cardiovascular system is unable to accommodate itself immediately to the sudden loss of circulating blood and the usual fall in the systolic pressure results. Generally however there is rapid accommodation on the part of the cardiovascular system so that the only aid that is needed to produce sufficient if not complete accommodation is the Trendelenburg position. In fact after the injection of the drug the patients are immediately placed in the Trendelenburg position without waiting for any further indication. Later when the accommodation has been established the head may with safety be raised slowly to the desired level. However if the patient's head is raised during the course of the operation he should be most carefully watched for sometimes the accommodation is not sufficient to offset this added burden. If the Trendelenburg position is not sufficient an understanding of the cause of the fall in blood pressure with its resulting syncope suggests the logical use of adrenalin and caffeine (usually in doses of 0.05 minims of the former and 2 grains of the latter) and if the condition warrants it the intravenous injection of saline and glucose. All of our cases readily recovered under this form of treatment but no time can be lost in deciding upon this treatment. One must not wait to see how the patient will be in a few minutes. Treatment must be prompt. We have a hypodermic of adrenalin and caffeine ready for instant use and are always prepared for intravenous injection.

The other immediate untoward result and the one that is more frequently seen is vomiting. It is not serious but it is annoying to the patient and to the operator. Just what the exact mechanism of this is we have not been able to determine to our complete satisfaction. Usually the patient does not actually vomit although he complains of severe nausea and gives every evidence of the vomiting reflex. It is perhaps better to call it a severe retching. It seems to be an admixture of both the toxic effect of the drug and the result of the upset in the cerebrospinal equilibrium due to the withdrawal of spinal fluid. It may be significant that it occurs more frequently in cases in which the injection has been high or in which a large dose has been given. It is usually controlled by inhalation of pure oxygen and never persists throughout the operation.

Of the several more remote ill effects of the anæsthesia the most frequent one is headache

Headache following apothesine is peculiar in the fact that it is postural. By this we mean that the patient complains very little if at all as long as he is kept in the recumbent position. But as soon as his head is raised the dull heavy generalized headache sets in. A return to the recumbent position brings almost immediate relief. The cause of this headache is not as yet clear but we are of the opinion that it has not so much to do with the toxic effect of the drug as with the disturbed cerebrospinal equilibrium resulting from the withdrawal of spinal fluid at the time of the administration of the anæsthetic. We have however seen it occur after the administration of scurocaine in which there was no withdrawal of spinal fluid. It perhaps occurs more frequently in cases in which a fall in blood pressure was especially marked at the time of operation but it is also occasionally seen in cases in which there has been no especial immediate untoward effect of the drug.

This latter fact somewhat confuses an understanding of the exact etiological factor in the headache. We believe that fewer headaches would follow the anæsthesia if the withdrawal of spinal fluid could be eliminated. In the use of apothesine however the withdrawal of spinal fluid is essential for the production of a satisfactory anæsthesia the same applies to novocain. Of course the purpose of withdrawing the fluid is to produce a diffusion of the drug over a wide area in the spinal canal so that a correspondingly wide area is anesthetized. This allows of a single injection in all abdominal operations whereas two injections of scurocaine are required in most operations. The same amount of spinal fluid is withdrawn in each administration regardless of the dose or of the area it is desired to anesthetize. In our experience the headache following the anæsthetic has not been of sufficient moment to off set the good effects of the anæsthesia. The headache responds best to caffeine by mouth and in the vast majority of cases subsides in a few days but occasionally may be quite troublesome and last as long as a week rarely more than 2 weeks. It has never been severe enough to delay the convalescence from the operation *per se*. We have never seen the severe headache immediately following the withdrawal of the spinal fluid that some authors speak of. This may be either a coincidence or due to the fact that we habitually withdraw the fluid very slowly. Whatever explanation for the headache is given and however successfully it is treated it nevertheless remains the most frequent and the most troublesome ill effect of apothesine anæsthesia. In our experi-

ence it occurs in approximately 1 out of every 15 cases.

The effect of the drug upon the motor nerves not infrequently produces a transient paralysis of the sphincter ani or of the vesical sphincter or the bladder musculature or both of the latter. This is always of short duration and requires no treatment other than an occasional catheterization if there is retention of urine. Catheterization is required more frequently after spinal anæsthesia than after general anæsthesia.

Occasionally the effect of the anæsthetic on the sensory nerves persists for a short time as paræsthesias in the lower limbs and a sense of numbness in the various segmental distributions of the sensory nerves. Very rarely indeed does the patient complain of pain referred along the course of the sciatic nerve. This has occurred in only three of our series of cases and has never been anything more than a transient complaint although some patients are psychically so affected that every ache and pain within reach of the site of the injection is attributed directly to the anæsthesia. This is to be expected and to be treated as the case demands.

TECHNIQUE OF APOTHESINE ANÆSTHESIA

Apothesine is chemically the hydrochloride of diethyl amino propyl cinnamate. It is obtained in the form of a white powder.

The dose of apothesine in the spinal anæsthesia is 0.01 grams (grains $\frac{1}{100}$) for each 15 pounds of body weight the minimum dose being 0.07 grams and the maximum 0.12 grams. In preparation for the injection the maximum dose 0.1 grams of the powder is placed in a small sterile bottle with a cork stopper. The bottle containing the powder is stoppered lightly and sterilized for 1 hour at a dry temperature of 60 degrees centigrade. From each group of bottles 10 sterilized ampoules are made of one or two and the remaining bottles are stoppered tightly and dipped in paraffin. The drug is then ready for use. If it has not been over sterilized it will not lose its potency with age.

In making the injection the technique is the same as that used in making any ordinary spinal puncture. The patient is most conveniently placed in a sitting posture and bent forward by an assistant so as to produce a convexity of the lumbar spine and to increase the space between the vertebrae. The spinous process must be as relaxed as possible—a condition difficult to obtain in the excitable patient. This makes it much easier cleanly and smoothly to enter the spinal canal. After painting the skin over the proposed site of

the injection with iodine and touching the area with novocain to obviate any pain due to the insertion of the needle the needle is placed exactly in the midline and is then pushed slowly and steadily forward and slightly upward. If bone is encountered the needle is slightly withdrawn and again pushed forward at an angle sufficiently varied from the first to miss both the vertebrae. The needle must enter the spinal canal exactly in the midline for otherwise even though spinal fluid is obtained some of the drug will be infiltrated into the surrounding tissue and a good take will not be obtained. When the spinal canal has been entered 10 cubic centimeters of fluid are routinely withdrawn. The spinal fluid is allowed to drip slowly through the needle into a medicine glass. As soon as 2 cubic centimeters have been collected this is drawn up into a hypodermic syringe and then mixed with the sterilized 0.12 gram of apothesine which has been previously placed in a small sterile bottle. Great care must be taken to assure the complete dissolution of the drug otherwise the results will not be good. The dose is then calculated as follows:

The cubic centimeters of spinal fluid is withdrawn with its dissolved apothesine from the bottle by means of a small syringe calibrated to minims $2\frac{1}{2}$ minims of this solution is allowed for each 15 pounds of body weight as each $2\frac{1}{2}$ minims will contain 0.01 gram of apothesine. Anything above the required amount is discarded.

This method of calibration is not an absolute one but is influenced more or less by the general physical and physiological status of each individual patient. Robust patients require larger doses than patients of the same weight but of less general physical stamina. It has also been found that when operations are performed on the upper abdomen and a relatively low injection is made a larger dose than that calibrated by the above method is necessary for a complete take. Conversely in cases in which the site of operation is in the lower abdomen or in patients of lowered general resistance smaller doses are not only sufficient but advisable. How great a deviation from the prescribed rule must be made in each instance is a matter requiring some experience. It is decidedly better to err on the side of conservatism.

While preparing the dose of the drug the spinal fluid is allowed to drip into the medicine glass until it measures 8 cubic centimeters when the obturator is placed in the needle so as to prevent the escape of any more spinal fluid. The dose of the drug contained in the hypodermic syringe is then placed into the 8 cubic centimeters of spinal

fluid in the medicine glass and the former well mixed with the latter by repeatedly drawing the solution into the syringe. A long large bore needle is then attached to a 10 cubic centimeter syringe and the entire quantity of the solution drawn up into the 10 cubic centimeter syringe care being taken that every drop of the solution is transferred from the medicine glass to the syringe. All air bubbles are then excluded from the syringe without losing any of the solution. This needle is then thrown aside and the syringe fitted into the needle that has been allowed to remain in the spinal canal. After first making sure that the connection between the syringe and needle is secure and after slightly withdrawing the piston of the syringe to show that the point of the needle is still free in the spinal canal the solution is injected. The amount of pressure used in this injection depends upon the amount of diffusion of the drug that is desired. For operations in the lower abdomen the amount of pressure is not of so much importance but for those in the upper abdomen it may be the deciding factor in obtaining a take or a failure. One must learn from experience just what pressure to use in each instance. Suffice it to say that high pressure is never necessary and is always inadvisable. The injection is made slowly and steadily whether or not the solution is mixed with the free spinal fluid by repeatedly withdrawing and re-injecting the solution depends upon the amount of diffusion desired. Some authors have advised against it because of the danger of producing a diffusion greater than that desired. Formerly we used this routinely for all operations in the upper abdomen but at that time we were making all of our injections in the fourth lumbar space. More recently we have obtained better results in operations in the upper abdomen by making high injections (second lumbar space) and using a relatively low pressure. We do not believe that the results of withdrawing larger amounts of spinal fluid (over 10 cubic centimeters) in order to obtain wider diffusion of the drug are of sufficient merit to offset the added danger.

At the completion of the injection the needle is quickly withdrawn and the puncture wound covered with collodion. The patient is then placed in the Trendelenburg position. Better results are obtained if 4 or 5 minutes are allowed to elapse before the operation is begun but we pay no particular attention to this having repeatedly demonstrated that the operation can be begun almost immediately with satisfactory results.

All patients are routinely given pure oxygen through a rubber tube placed in one nostril.

This is the most efficient agent in controlling the severe retching and nausea which often follow the anæsthesia

TREATMENT OF UNWELCOME SYMPTOMS

There are three methods of treatment used in the control of the immediate ill effects of the anæsthetic. As before stated these symptoms are all due primarily to a fall in the systolic blood pressure. The treatment is therefore directed to the correction of this change. For the minor symptoms the Trendelenburg position often suffices but if this does not correct the symptoms a hypodermic of adrenalin and caffeine should be given. As a rule we give 20 minims of adrenalin and 0.1 gram of caffeine. If in a reasonable time this is not followed by improvement an intravenous infusion of saline and glucose is given. The amount of the infusion varies with the patient and the severity of the symptoms but as a rule we give 1000 cubic centimeters of saline and 50 grams of glucose. We have never as yet seen a patient fail to respond to this type of treatment and it is seldom indeed that the severity of the symptoms demands the infusion. Patients showing these immediate reactions are carefully watched for the succeeding 12 hours. The foot of the bed is kept elevated and hypodermic injections of caffeine and adrenalin are given as indicated. By the end of 12 hours practically all patients show a very decided improvement and with this the routine postoperative treatment proceed as usual the only difference being that water by mouth can be given at an earlier period than in cases in which a general anæsthetic is given.

REPORT OF CASES

Over a period dating from March 1924 to March 2 1927 inclusive 2251 cases operated upon in this clinic received apothesine anæsthesia. Of these all but 57 were regarded as takes i.e. the anæsthetic produced anæsthesia and relaxation without the aid of a general anæsthetic. In these 57 cases the anæsthetic was not sufficient to produce the desired relaxation and a general anæsthetic had to be given before the operation was begun. There was a certain percentage of cases in which gas and oxygen was given for various reasons (1) to allay the psychic excitement of the patient (2) to prolong the anæsthesia when the operation extended over a considerable period of time and the anæsthesia showed signs of wearing off before the completion of the operation (3) to control especially severe retching which has failed to respond readily to inhalations of oxygen.

An infusion of glucose and saline was found necessary in approximately two out of every one hundred patients and an injection of caffeine and adrenalin was given in about one out of every eight cases receiving spinal anæsthesia. Vomiting or retching occurred in practically every case at some time during the course of the operation. Usually this was easily controlled by inhalations of oxygen. In no case was there a mortality attributed to the effect of the anæsthesia.

Of the other sequelæ of the anæsthesia such as incontinence of urine and feces paræsthesias of the leg no definite record was kept but we know that they were common sequelæ and that they all recovered spontaneously. We have had three patients in this series who complained of pain along the course of the sciatic nerve for from 1 to 4 weeks after the operation and in the absence of any other demonstrable cause for this symptom we have been obliged to consider it as being in some way due to the use of spinal anæsthesia.

Our experience with apothesine has naturally become more satisfactory as our practical knowledge of it has increased. We have gained much by carefully searching for the causes of failure in unsatisfactory cases. In the great majority we have found that this was due to one of three things.

1. Occasionally a smaller dose of the drug was injected into the spinal canal than was calculated. This was because the anesthetist failed to make sure that all of the apothesine was dissolved before making the injection. The drug is sometimes in the form of small granules which though high in potency dissolve slowly. It is only too easy to fail to allow sufficient time for these granules to dissolve as they form a very small part of the powder and may therefore be overlooked. The bottle containing the solution should be held up to the light and frequently shaken in order to make sure of a complete dissolution of the drug.

The introduction of the needle into the spinal canal was not made cleanly and smoothly. If the point of the needle does not lie free in the spinal canal a certain portion of the injected drug will be infiltrated into the surrounding tissues.

3. The mistake of selecting a highly nervous neurotic patient for the anæsthetic. This type of patient has given us the greatest amount of trouble with the sequelæ of the anæsthetic such as headache. Why this is true is difficult to understand but it is a fact that these patients do better under general anæsthesia. In

operations on the upper abdomen the anæsthetic is not so satisfactory as in those in the lower abdomen but its efficiency is well marked in enough cases to justify its use. We have had better results in these cases with high injections (second lumbar space) than with low injections and although there is greater tendency to retching at the time of operation, there are no sequelæ immediate or remote which contra-indicate its use. For some time we have tried certain changes in our technique with the idea of preventing the occurrence of the fall in blood pressure and the retching which so frequently follows the anæsthesia. Recently some progress has been made in this direction by injection of adrenalin subcutaneously (for slow absorption) immediately after the injection of the drug into the spinal canal. While it has proved to be of undoubted

value it has not entirely prevented these sequelæ.

As stated above we believe spinal anæsthesia has its place in the realm of anæsthetics but we do not consider it ideal or to be used routinely. In some instances it certainly has approached the ideal but its occasional unexplained total or partial failure denies its being generally speaking a completely satisfactory anæsthetic. However when used properly it is the best anæsthetic available at the present time. We use apothesine because we know of no drug taking all things into consideration that is better. We use it because we believe in its safety and its comparative efficiency but we use it with the feeling and hope that some day it will be discarded for a better anæsthetic. Adopting a popular advertising slogan—when a better anæsthetic is found we'll use it.

RADIUM IN THE TREATMENT OF UTERINE PATHOLOGY¹

By IRVIN ABELL, M.D., F.A.C.S., LOUISVILLE, KENTUCKY

THE indications for the use of radium in the treatment of pathological lesions of the uterus have been since 1920 rather definitely defined its dangers and the contra-indications to its employment have become equally clear. While it has not proved as widely efficacious as at first thought to be its results in certain conditions have been demonstrated to surpass those of any other treatment heretofore employed. A brief review of the writer's limited personal experience with it in the treatment of carcinoma of the cervix carcinoma of the body fibromyomata and uterine hæmorrhage of functional origin is presented as a basis for discussion of some of the problems with which such lesions are associated.

CARCINOMA OF THE CERVIX

As I became convinced that irradiation in carcinoma of the cervix offered definite advantages over the various surgical measures employed I have since 1921 considered irradiation the treatment of choice. The considerations and observations leading to this conclusion were the greatly lessened mortality and morbidity entailed by the use of radium as compared with operative measures. The three conditions which obtained in every radical operation for cancer of the cervix blood loss trauma and prolonged anæsthesia are eliminated thereby obviating the reduction in tissue reaction and general vitality which these

factors produce. The ultimate results as related to prolongation of life and apparent cure compare favorably or excel those of operation. All but the most advanced cases can be benefited to some extent by its employment and though they finally succumb to the disease they are frequently spared the suffering induced by the hæmorrhage and infection from the foul sloughing vaginal mass. By far the vast majority of cervical carcinomata is of the epidermoid type which are quite susceptible to destruction by irradiation. Up to and including 1926, 50 patients with carcinoma of the cervix have been treated with radium alone and 1 with implantation of radium in the field of operation after panhysterectomy. In this latter patient age 49 years operated on in June 1921 the uterus and broad ligament lymph nodes which were palpably enlarged were removed the vaginal vault was left open and two 50 milligram capsules of radium were introduced one in each broad ligament held in place by gauze packing and removed through the vagina. This was followed by marked pelvic reaction the entire pelvis became filled with a hard sensitive mass accompanied with much burning pain in bladder and rectum. During the third week some incontinence of urine was noted although the patient passed from 40 to 50 ounces of urine from the bladder daily. Eight weeks after operation and irradiation the mass was smaller and incontinence had all but

disappeared when a large mass of sloughing tissue was extruded from the vagina following which total incontinence obtained. Cystoscopy September fourth 10 weeks after operation showed a large vesicovaginal fistula. Death followed some months later from pelvic-abdominal extension.

Of the 30 treated with radium alone were in the third decade ages 2 and 25 years were in the fourth decade ages 32 and 34 years 7 in the fifth 1 in the sixth and 7 in the seventh decades. The dosage given has been on an average of 3 000 milligram hours. The patients treated during 19 were as a rule given smaller doses and it is interesting to note that 2 of these given respectively 2 400 and 3 000 milligram hour doses are known to be living and apparently free from recurrence now in their fifth year since treatment while a further group of 3 given respectively 2 000 3 000 and 2 400 milligram hour doses and now in their third year since treatment are known to be well and apparently free of disease. Of the 31 patients in this group 16 have been able to trace 29 of whom are known to be dead 9 are living and state that they are apparently well and 4 while living are known to present evidence of the continued presence of cancer.

One death occurred as the immediate result of the radium application the patient age 40 years presented an epidermoid carcinoma involving chiefly the anterior lip of the cervix presenting as a large cauliflower mass. This latter made entrance into the cervical canal difficult and in part was removed with the curette to facilitate the introduction of the radium into the canal. Forty-eight hours later she developed a temperature of 103 degrees from which time on she presented the evidences of sepsis complicated by a severe hæmorrhage on the seventh day requiring packing for its control and died on the eleventh day from what in the light of its clinical course was interpreted as septicæmia.

In addition to the vesicovaginal fistula mentioned above one other has been noted. The patient age 50 years came under observation in October 1921 with a vesicovaginal fistula which had followed an hysterectomy in the preceding April which she stated was done for cancer. As no evidence of the latter could be detected the fistula was repaired by the ordinary surgical measure. She was not seen again until 3 years later December 19 4 when he presented cancerous induration and ulceration in the vaginal vault. She was given a 1 000 milligram hour dose of radium in January 19 5 followed later by X ray. In July 6 months after the radium and immediately after the last of 6 X ray treatments

incontinence of urine was noted. Examination in October showed both a vesicovaginal and a recto vaginal fistula and while the patient is now still alive she is slowly but surely approaching the inevitable end. The development of fistula in these 2 cases is in harmony with the known observation of their liable occurrence when patients presenting infiltration of vesico and recto vaginal septa are irradiated and emphasize the importance of extreme caution both in dosage and technique of application when such involvement exists. In fact in the utterly hopeless cases the possibility of fistula formation would seem to question the propriety of irradiation since such annoying complications but add to the patient's discomfort. In so far as known no patient has developed pyometra but many have complained of persistent mucopurulent discharge which has proved resistant to treatment.

CARCINOMA OF THE FUNDUS

The use of radium alone in the treatment of carcinoma of the body of the uterus is believed by the writer to be contra indicated for the following reasons. Cancer of the fundus is usually of the adenocarcinomatous type which does not readily respond to irradiation its known tendency to metastasize to the ovaries makes it desirable to remove these organs in every case and imperative to remove them if such metastasis has occurred in order to obtain a cure. Finally the results of surgery in permitting the ablation of more cancer bearing tissue are superior to those of radium.

We have employed radium alone or in combination with panhysterectomy in seventeen patients ranging in age from 31 to 68 years. The limitation of the treatment in 11 patients to radium alone was made necessary either by the presence of general physical conditions which prohibited the employment of a major surgical operation or to demonstrable extension of the disease beyond the uterus in the latter instances being used as a palliative measure for the control of bleeding. Of these 11 are dead death occurring in from 6 months to 3 years after irradiation 2 are living and well and 6 years respectively after treatment while 2 are living with demonstrable disease present and 6 years after initial treatment. Since the physical condition of this group precluded operation radium has afforded a prolongation of life in comparative comfort for as long as 6 years while in 2 no further evidence of the disease can be detected. The dosage in these 11 cases varied from 400 to 3 000 milligram hours. In the 6 instances in which radium was employed in conjunction with panhysterectomy

its use as a pre operative measure was not an intentional one. It has been our practice to do a diagnostic curettage on every patient presenting uterine pathology on whom the use of radium is contemplated. In 6 patients presenting uterine hemorrhage as a major symptom a curettage was done and radium applied. Subsequent examination of the removed tissue revealing adenocarcinoma panhysterectomies were done within the week. In so far as known 5 of these done from 1 to 3 years ago are well while the sixth showed a recurrence at the end of 10 months. The location of this recurrence was of interest in that it was situated in the anterior vaginal wall below and to the left of the outer terminal portion of the urethra. Further irradiation but temporarily inhibited its spread.

FIBROMYOMATA OF THE UTERUS

The indications for the treatment of fibromyomatous growths involving the body of the uterus are variously interpreted by surgeon and radiologist. The logical analysis of the situation appears to me to be as follows: in women under 40 presenting such growths the treatment of choice is surgical removal employing transfusion and irradiation in moderate dosage for the purpose of making operable those patients in whom continued bleeding and profound secondary anemia temporarily prohibit operation. The reasons for this conclusion are—first ocular inspection will in some cases permit of myomectomy with the preservation of the child bearing function; second preservation of the ovaries independent of the retention or ablation of the uterine body is of importance. The younger the patient the greater the importance of the preservation of the ovaries because of their internal secretion and the part they play in the establishment and maintenance of the sex function particularly in the earlier years of life. Again many women have an abhorrence of the induced menopause regardless of how produced whether by surgical removal of the ovaries or their destruction by radiation. Irradiation of fibromyomata in such women may engender an inferiority or abnormality complex rendering them unhappy for the remainder of their days and surely mental tranquility transcends in importance the 2 per cent risk which operation entails. It is readily admitted that there is an opposite picture to this namely those who desire and prefer irradiation even though it involves destruction of the ovaries rather than operation with its concomitant pain discomfort confinement and convalescence. At and after the age of 40 years the child bearing function of the

uterus has usually been fulfilled the distortion of the organ incident to the growth may be such as to prevent conception or to interfere with pregnancy granting its occurrence and the proximity of the approaching menopause makes negligible the importance of ovarian preservation. Hence irradiation at this age finds a comparatively wide field of usefulness its limitations being determined by the size of the tumors and their situation by pedunculation by tumor degeneration and by adnexal disease. We have employed radium alone in the treatment of 15 patients with fibromyomatous uterine growths but 2 were under 40 (37 and 39 respectively). 8 were between 40 and 50 and 5 between 50 and 55 years of age. In 1 patients the tumor was at or below the size of a 3 month pregnancy in the size of a 4 month pregnancy and in 1 that of a 6 month pregnancy. The dosage of the radium has varied with the size of the tumor from 100 to 3,000 milligram hours. Bleeding has been controlled in every patient and there has been an appreciable reduction in size or disappearance of the tumor in all but 3. In the first of these a diabetic age 54 years with a tumor the size of a 3 month pregnancy a 3,000 milligram hour dose of radium was given September 1923. In January 1924 while bleeding had ceased an annoying vaginal discharge was present and at times discomfort was noted in the tumor which had not decreased in size. Supplementary X ray treatments were made to tumor in January and February. The last examination April 17 1924 showed but slight reduction in size of the growth. The second age 50 years presented a multinodular tumor the size of a 10 week pregnancy. In May 1925 a 1,500 milligram hour dose of radium was applied. By September 1924 the tumor had increased in size until it filled the pelvis and extended into the right half of the abdomen as high as the umbilicus. At operation it was found that the tumor mass originating in the body of the uterus had remained stationary in size or possibly was slightly smaller than at the time of application of radium while the massive increase in size had occurred in two subperitoneal nodules one of which showed calcareous deposit. In the third patient age 45 years presenting a multinodular growth of the size of a 4 month pregnancy surgical removal was advised and declined with insistence upon the use of radium a 2,400 milligram hour dose was given. Pain in the tumor was noted on the fifth day accompanied by a temperature varying from 99 to 101 degrees until the ninth day when a severe rigor was followed by a temperature of 102 degrees and

a leucocyte count of 5000. Surgical removal was again advised and declined. The fever and leucocytosis continued with nausea and anorexia present necessitating the administration of glucose intravenously as a means of nourishment. The tumor increased in size reaching as high as the umbilicus or approximately the size of a 6 month pregnancy. The blood culture was negative. Exploration through a low left paramedian incision revealed no evidence of adnexal disease and exploratory aspiration of the tumor revealed no abscess. Death occurred at the end of 5 weeks from septic intoxication and exhaustion. While in the remaining 7 patients cessation of bleeding and diminution of tumor occurred a marked reaction was noted in 2 cases. One a patient 45 years of age had been operated on by me for cholelithiasis at which time examination through the abdominal incision showed the pelvic organs to be normal. Eighteen months later she reported with a history of profuse bleeding a blood count showing hæmoglobin of 50, red cells 3,000,000 and white cells 7,500 with a rounded myomatous growth 3 to 4 inches in diameter involving chiefly the posterior uterine wall. She was given a 3,000 milligram hour dose of radium followed on the seventh day by a temperature of 102 degrees and severe pelvic pain. The uterine tumor increased in size the fever continued the pain required opiates for control the leucocytosis varied from 12,000 to 15,000 and on the twenty third day following irradiation examination under an anæsthetic revealed the following: pelvis filled with a large mass directly continuous with uterus filling the cul de sac extending well out into both broad ligaments and on the left side it was felt well above the pubes. The entire mass was hard presenting no areas of softening. The aspirating needle introduced back of cervix failed to detect pus. Examination per rectum showed the mass to be adhered to the rectum and the lumen of the latter to be appreciably decreased by the inflammatory swelling. She was able to leave the hospital on the thirty third day making a tardy and tedious convalescence. Examination 155 days after irradiation showed the tumor to have disappeared the uterus freely movable the broad ligaments free and the blood count normal. The second patient 5 years of age with a fibromyoma of the size of a 4 month pregnancy was given a 3,000 milligram hour dose of radium. While the tumor decreased in size its reduction was accompanied by pelvic pain and burning in bladder and rectum with a bloody discharge from the latter necessitating a prolonged confinement to bed. Six months following irradiation the tumor

was less than half the original size but the patient still complained of pelvic pain and rectal irritation.

The largest tumor of the series was irradiated primarily for the purpose of controlling bleeding and making the patient operable. Age 50 years she presented a tumor the size of a 6 month pregnancy a perfect heart was in the anterior axillary line with a loud systolic mitral murmur legs oedematous to knees hæmoglobin 68, red cells 3,500,000 white cells 8,900. She was given a 3,000 milligram hour dose of radium with a most happy result at the end of 6 months the tumor had reduced to the size of a 2 month pregnancy there had been no further bleeding the oedema and heart murmur had disappeared and she was symptomatically at least well.

UTERINE BLEEDING OF FUNCTIONAL ORIGIN

In the treatment of this pathological condition radium stands practically as a specific finding in this field its most brilliant and consistent successes. The bleeding has been designated as myopathic metropathic idiopathic and functional the latter representing the view that is coming into general acceptance. The clinical observations offered in support of it are that the hyperplastic glandular endometrium and the bleeding occur only during the era of ovarian functional activity that both recur after curettage and that both disappear after removal of the ovaries or radiotherapy. Further that the removed ovaries of such patients have shown a large number of maturing follicles with an absence of corpora lutea. We have treated 70 such patients with radium their ages ranging from 14 to 40, 1 being in the second 10 in the third 22 in the fourth 9 in the fifth 6 in the sixth 1 in the seventh and 1 in the eighth decades.

Physical examination showed but little if any variation from the normal in the size contour mobility and position of the uterus with negative appendages the one symptom being the bleeding. Microscopical examination of the endometrium removed with the curette has shown two types of pathology a round celled infiltration with vascular engorgement and an hyperplastic glandular endometritis. One cannot emphasize too strongly the advisability of subjecting all curetted particles to microscopical analysis in order that endometrial carcinoma may not be overlooked. It is conceded that curettage suffices to cure many such cases but an appreciable number are but temporarily benefited by this procedure while the condition in others is actually aggravated thereby. It is in this definite class of cases that we find the true problem of the bleeding uterus.

a problem that before the advent of radium required hysterectomy for its solution. Radium as a rule requires but one application and the dose can be measured fairly accurately according to whether one wishes to diminish the uterine bleeding or to produce complete cessation of menses. The induction of the menopause by radium implies the loss by the ovary of its internal secretion and of its follicular activity, consequently in case of intractable bleeding not controlled by moderate doses it would seem wise to induce the menopause with radium only in those patients approaching middle age, reserving the surgical removal of the uterine body for younger women since it permits of the preservation of unimpaired ovaries. The dosage in this series has varied from 150 to 400 milligram hours depending on the desired result to be achieved. But 3 of the 70 patients returned on account of recurrence of bleeding. One of these, an unmarried patient age 30 years was under observation 3 years during which time she was curetted twice, had 2 applications of radium of 600 milligram hours each, transfusions of whole blood, 2 administrations of horse serum, glandular extracts, iron, arsenic, calcium salts and various styptics including ergot, hydrastis and stypticin with but temporary control of bleeding. Following a preference for removal of the uterus in young women rather than induction of the menopause with radium, a supracervical hysterectomy

with removal of a cystic right ovary was done. Microscopical examination of the specimen showed chronic endocervicitis, chronic endometritis and simple cysts of ovary. But one patient age 49 years showed any marked reaction, doubtless due to a parametrial inflammation present at time of application of radium, the ultimate result being satisfactory. One patient has noted marked vaginal spasm and dyspareunia since irradiation and another has complained of monilial pruritis. While a certain amount of vaginal discharge is almost routinely noted following radium treatment such flow is usually of short duration and responds readily to soothing douches. In a small number of patients an intractable irritating vaginal discharge has persisted for months. Recent communications have been received from 5 patients of this group, 36 of the 70 ranging in age from 38 to 50 years to whom a dosage of from 1000 to 400 milligram hours was given, report complete cessation of menses, 16 ranging in age from 16 to 36 years to whom doses ranging from 150 to 800 milligram hours were given, 13 report menstruation normal in quantity, 12 as normal for years at which time radium was again used in an other clinic, 12 as normal for 1 year when a curettage was done elsewhere for recurrence of bleeding and 1 reports the bleeding as markedly lessened but still greater than her normal.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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THORACIC CONTRAST MEDIA ROENTGENOGRAPHY

THE use of the roentgen ray in diagnosis based solely on the relative translucency to it of the tissues and organs of the body though invaluable would be of decidedly limited application. Lesions involving no marked or extensive change in normal tissue densities such as ulcers, strictures, dilatations, soft tumors and abnormalities in the relative position of organs would be for the most part unrevealed. The principle of contrast media delineation removed this limitation in proportion as suitable media and proper technique for their introduction were developed. Such delineation of gastrointestinal and urinary tract lesions marks one of the greatest achievements in modern diagnosis. The Graham-Cole method of visualizing the gall bladder involved the finding of a substance opaque to the roentgen ray for selective liver secretion.

The limitations of unaided thoracic roentgenography are less marked because the air in the lungs acts as a normal contrast media bringing structures into sharp relief and accentuating the shadows of inflammatory or neoplastic increase in density.

There have been nevertheless very real and serious limitations to the roentgen ray diagnosis of thoracic disease. A uniformly thickened pleura or a pleural effusion clouds the contrast media effect of the air in the lungs and effectively masks any coexisting pulmonary lesion. Intrapulmonary shadows that are revealed may also be of uncertain or indeterminate significance. The heart and dome of the diaphragm overshadow markings of lung pathology. Air-containing dilatation or cavities or strictures of bronchi may produce no definite findings. The exact status of fistulous tracts and empyema cavities is not demonstrable without the use of suitable contrast media.

The great value of bismuth paste in the study of sinuses and cavities was brought out by Beck, but this media if introduced under pressure into an empyema sinus may produce symptoms of serious cerebral manifestation sometimes suddenly fatal. It is also unsuited for intratracheal injection of the bronchi. Solutions of sodium iodide or other salts serve well to outline empyema cavities but are too irritating to be injected into the bronchial tract.

The possibility of visualizing the bronchial tree roentgenographically was suggested by the accidental penetration of small amount of bismuth paste into the trachea through tracheal oesophageal fistula. In 1918 Chevalier Jackson succeeded in outlining the right bronchus by insufflating into it bismuth powder through the bronchoscope. Two years later Lynah reported 2 cases of pulmonary abscess similarly visualized. The necessity for bronchoscopic introduction of the powder and

its limited distribution, however would probably have greatly limited the applicability of this method even if more suitable media had not been developed. The preparation of 40 per cent metallic iodine in poppy seed oil introduced by Sicard and Forestier in 1911 making roentgen ray bronchography relatively safe and practical promises to be as notable an achievement in the diagnosis of thoracic diseases as the bismuth meal or enema has proved in that of the gastrointestinal tract. The 'iodopin' of the Germans and 'iodumbrin' of the Danes are similar preparations.

The greatest field of usefulness of these contrast media is in the differential diagnosis of bronchiectasis which next to tuberculosis is the most common chronic pulmonary disease.

The physical signs of bronchiectasis are often limited to a few rales and the roentgen ray findings to linear shadows of uncertain significance. In combination with chronic cough and an abundance of purulent sputum showing no tubercle bacilli these findings should serve to establish the diagnosis but the type and distribution of the bronchiectatic dilatations remains indeterminate. It is often impossible to differentiate between unilateral and bilateral involvement except perhaps bronchoscopically. The disease has often masqueraded for years as chronic bronchitis, tuberculosis, abscess or recurrent colds. Early diagnosis has been the exception. It has probably never been diagnosed with certainty in its incipency. The dry type of bronchiectatic dilatations producing no cough or sputum presumably of congenital origin probably has never been recognized except at necropsy. In the iodized oil contrast media we have a means of visualizing the dilatations in the earliest stages of the disease when most amenable to treatment and of determining objectively the best type of treatment. Bronchiectasis coexisting with thickened pleura, empyema, tuberculosis or

subphrenic abscess can be recognized with certainty only by such contrast media visualization.

Pulmonary abscess with wide open communications with a large bronchus may be directly visualized with iodized oil if empty or after having been emptied bronchoscopically but the oil may entirely fail to gravitate into those with imperfect drainage notably those situated peripherally. In many such cases the injection of the bronchus leading to the displaced area of the lung furnished indirect evidence of the presence of an abscess in that the lipiodol fails to penetrate into the terminal bronchus in the surrounding consolidated lung tissue. This abrupt ending of the bronchial shadows also serves to differentiate between lung consolidation and localized pleurisy with or without effusion. After thoracotomy drainage the lipiodol may give an excellent delineation of a multilocular abscess cavity and of its fistulous ramification.

In empyema the method is of great value in establishing the presence and ramifications of bronchial or intrapleural fistulous tracts or multiple communicating cavities.

Bronchogenic tumors of the lung, the incidence of which seems to be on the increase as a rule are recognized late if at all clinically. The dilatations or blockage of the bronchi as shown by the injected oil whether with or without symptoms of infection suggest the possibility of a neoplasm as the underlying lesion.

In pulmonary tuberculosis the method serves to outline cavities and secondary bronchiectasis but cases have been reported seeming to show that the iodine gradually set free may stimulate the tuberculous process to renewed activity. The value of the visualization is also minimized from the standpoint of treatment as indications for compression therapy must usually be determined on other grounds.

The application of the principle of contrast media roentgenography to the study of the diseases of the thorax made possible by the development of iodized oil thus seems of the greatest importance to their earlier and more accurate diagnosis and more rational and effective treatment

CARL A. HEDBLÖM

THE SPLEEN

THE spleen cannot be regarded as an organ apart but only in relation to various systems—lymphatic, circulatory, portal and reticulo endothelial. It is affected reflexly by various forms of stimulation and in turn has a direct effect on the blood.

Removal of the spleen in man preceded its removal in the experimental animal and much of our knowledge concerning the spleen has been derived empirically as a result of extirpation of the spleen. It is interesting to note that many of the views of the ancients have been corroborated. Anatomical and pathological studies have failed to throw much light on the function of the spleen but recent physiological and chemical research has revealed interesting facts which seem to indicate that our fundamental knowledge will be obtained by experimental work.

Although the spleen contains a large amount of lymphoid tissue the activities of this tissue are not clearly understood and it is only in pathological lymphocytic hyperplasia of the spleen that the lymphoid characteristics assume prominence. It has been clearly shown that the normal spleen exerts a balance on the circulation both with respect to blood volume and the number of erythrocytes especially during exercise and hemorrhage. The direct effect of removal of the spleen on the amount of blood passing through the liver has been demonstrated: the enlarged spleen in certain pathological states contains enormous quantities of blood and in these cases the degree of

relief of the load on the diseased liver assumes definite proportions. The effect of the spleen on the blood is demonstrated by the recovery of the normal platelet count in cases of hemorrhagic purpura following splenectomy; the recovery is so rapid that a direct effect must be postulated and it is probable that in this disease the spleen destroys platelets possibly chiefly the older forms of platelets. The reaction of the spleen in chronic infectious processes seems to have little to do with the reticulo endothelial structures; it affects chiefly the circulatory system and fibrous tissue producing chronic fibrosis and often infarcts.

The idea is general among the laity that persons from whom the spleen has been removed do not live long. This misunderstanding is doubtless due to the fact that in many instances the spleen has been removed not with the expectation of cure but with the idea of prolonging life. It seems important therefore that the public should be informed that cure can be expected only in certain diseases of which the outstanding examples are hemolytic icterus, purpura hemorrhagica, plenic anemia and syphilitic splenomegaly. Results obtained from splenectomy in cases showing the syndrome of splenic anemia are unsatisfactory partly because splenectomy has been performed in cases in which on careful study the condition seems to be the result of a chronic recurring infectious process.

The most interesting problems at present from the experimental standpoint are those in connection with the spleen as a part of the reticulo endothelial system and from the clinical standpoint are those concerned with the determination of the advisability of splenectomy in the individual case. This after a satisfactory diagnosis has been reached seems to be chiefly decided by satisfactory function of the liver and absence of evidence of chronic recurring infection. H. Z. GIEFFY

Agnew was of Scotch Irish descent and inherited his height since his great grandfather Robert the shortest of seven brothers measured 6 feet 2 inches His grandfather David one of nine children became the father of twelve and died leaving a widow who married a widower whose children numbered seven

His father Robert Agnew a graduate of Dickinson College a surgeon of note and an elder in the Presbyterian church married a handsome widow the mother of two children who bore to him David Hayes Agnew The latter received his literary education at Jefferson College Canonsburg Pennsylvania the stronghold of Presbyterianism subsequently becoming part of Washington and Jefferson College at Washington Pennsylvania and writes of this institution he then being eighteen years old that the refectory was infamous the food was poor and badly served a criticism which has always been voiced of all educational institutions by each generation of students

After graduation from the Medical Department of the University of Pennsylvania Agnew practiced at Nobleville and Christiana for three years He records at this time that it was hard riding hard reading hard working small fees He played the violin followed the hounds owned and rode a famous horse of the Tom breed was a lover and trainer of dogs and was known throughout the countryside as a dead shot and a judge of horses

Marrying into a family interested in the iron business he was persuaded to abandon for a time the practice of medicine in favor of a business career His firm later assigned and it is worthy of note that Agnew ultimately paid every penny of the loss sustained by those who invested therein

Thereafter he returned to the practice of medicine and settled in Cochranville Chester County Pennsylvania but remained as in student days vividly interested in anatomy securing bodies for the purpose of dissection and study from Philadelphia and placing the bones in a pond to be cleaned by the eels which were much esteemed as food by the community Agnew's method of fattening them was not approved nor for that matter was the use of the human body for scientific purposes Falling into disfavor in his community he determined to settle in Philadelphia but at the request of Dr Sample took charge of the neglected practice of the latter's son at Soudersburg ten miles from Lancaster Speaking of his experience there many years later Agnew said I located at Soudersburg when a young man I stayed there long enough to know all the roads in the district but I found the people there wanted a better doctor than I was likely to prove so I moved

It was perhaps at this time that he found some comfort in Voltaire's definition of a physician An unfortunate gentleman who is obliged to perform a miracle every day in reconciling himself with intemperance

Coming to Philadelphia finding at last his energy into his school of which he too he threw all his in 1832 At this time

the use of the human body for dissection was not regarded with such favor by the laity nor with such large tolerance by legislators as to make the securing of adequate material other than difficult and dangerous. Agnew's supply was always adequate. During the cholera epidemic he might have been but forunately was not found in those trenches where the almshouse bodies were dumped injecting by day and resurrecting by night.

During the more than ten years of his control of the anatomical school he delivered over 1800 lectures teaching and demonstrating both summer and winter. An associate Dr. Garretson speaks of him as having an uniquely un-spectulative mind on the subject of religion. When questioned as to body, ego and soul, Agnew briefly replied that he was sure of the body, was willing to leave the ego to philosophy, the soul to the church.

Agnew's growth to the master position was slow, even slower was the recognition by the schoolmen that he had attained this growth. Appointed by Leidy demonstrator of anatomy in the University of Pennsylvania, he remained in this minor position seven years, when because of his increasing practice tendering his resignation, he was made professor of clinical and demonstrative surgery, this when he was 52 years old and had been practicing medicine thirty-one years. A year later he was made professor of surgery, retaining this position for eighteen years.

By the early eighties Agnew was recognized by both the medical profession and the laity as the master surgeon of America, by the medical profession because of his headship and conduct of the Philadelphia School of Anatomy, which meagerly equipped and with but nine students, he bought in 1851 for six hundred dollars and sold for the same sum in 1863 with full equipment and 267 students, the world's largest private class under an individual teacher, also his leading rank was accorded him by the profession because of his large army and hospital experience, his textbook on surgery and his papers on applied anatomy, which were recognized and accepted as standard of authority.

Hence when President Garfield was shot in 1881, his attending surgeon looked on Agnew as the obvious consultant. His connection with this case and his bearing throughout stamped him to the layman as a leader.

As Garfield about to take a train was passing through the Baltimore and Potomac Railroad Station, he was shot, the bullet entering four inches to the right of the midline of the back at the level of the eleventh rib. Garfield fell and when carried to the second story of the station was pale, cold, wet, thirsty, vomiting, with a running pulse and suffering severe pain and marked hyperæsthesia of the legs, particularly marked on the right side. The surgeon promptly probed downward to the depth of 3½ inches and followed his metal instrument by his little finger introduced to its full length.

The reaction from shock was slow but complete. The next day the surgeon general made a further digital exploration of the wound tract and of the

consultants called on the third day it is stated they did not attempt to force their probing with too much vigor. There is no record to the effect that Nelaton turned in his grave nor that Lister groaned aloud though there was at the time a protest regarded by both the profession and the laity as inspired by envy and voiced by the votaries of the false god antiseptis whose credo failed to recognize wound suppuration as inevitable and whose cult enforced a time consuming ritual with results no better if as good as those incident to methods sanctioned by the centuries. Agnew called on the third day decided against operation and thereafter was concerned with insuring drainage for an abscess burrowing into the iliac fossa and for other septic manifestations among them sloughing parotids.

When death occurred some two and a half months later the bullet was found harmlessly encysted remote from the suppurating area which centered around an osteomyelitis at the seat of the shattered vertebral body.

Agnew was brought up strictly in the tenets of Presbyterianism attended church regularly refusing all posts of honor therein. He saw on Sunday only those patients whose needs were urgent was quietly deeply and consistently religious.

As a teacher he had that rare gift of clarity accentuating and illumining the high points avoiding unessential and confusing details. He believed and taught that surgery should be based on a brain eye and hand knowledge of anatomy a sharp knife fingers trained in its use practiced diagnostic ability and an understanding heart tender toward the afflicted and with the single purpose of bringing help to both body and mind.

This being before the efflorescence of specialists subjects now relegated to them were grouped in the surgical course among them affections of the skin which Agnew briefly covered by the statement that they might be classified under two headings namely those which are cured by the application of zinc oxide ointment and those which are not thus cured.

He believed that woman's place was in the home that her education should be confined to reading writing arithmetic belles lettres and housekeeping and was so opposed to her as a medical student that he resigned from the Pennsylvania Hospital staff rather than have one or more attend his clinics.

He was among the first in this country to practice the ritual of Listerism this at an age when upon many minds a new idea has the effect of a foreign body upon the grosser tissues and is either encapsulated and disappears or sets up an irritation and is extruded. (J. William White)

He was ambidextrous deft and swift in his manipulations without seeming so to be. Students crowded his clinics in particular those devoted to cutting for bladder stone. When a patient was assuredly diagnosed by means of a resonator attached to a steel sound and was duly prepared with a grooved staff passed into the bladder Agnew would make one ample perineal cut into the posterior urethra drop

his sharp pointed knife take from his teeth his blunt pointed one make with it one further ample cut through a lateral lobe of the prostate insert his forceps and remove the stone in less than six seconds and with a deceptive appearance of deliberation

Agnew was a scrupulous observer of professional etiquette both in action and in spirit Operating upon a patient suffering from a long continued suppuration following an operation by a brother practitioner Agnew made one deep free incision seeming to his resident perilously near the femoral artery passed in two fingers so neatly palmed a lingering sponge which had been the cause of the trouble that it was seen only by his assistant and made no remark other than this free drainage should cure your patient Doctor

Agnew died of angina pectoris aggravated by influenza To his students and colleagues he was Master not only because of his textbooks his honors his manual dexterity and surgical skill his diagnostic acumen his clarity of thought and expression but because of a personality which in either group or individual contact left an impression of singleness of purpose of joy in service of sympathy with weakness of an understanding heart A personality actively and beneficently contagious

In the University of Pennsylvania there is an Agnew wing endowed by the Master In the Library of the College of Physicians there is an admirable Biography of D Hayes Agnew written by his nephew Dr Howe Adams and from which much that has been written in this sketch has been taken

Even the most powerful in his day and generation is promptly forgotten unless he leave a named legacy The Agnew wing should be the Master's benediction for many generations of teachers students and patients EDWARD MARTIN

D Hayes Agnew was born in 1818 died in 1892 He received an M D degree at University of Pennsylvania in 1838 He was owner and conductor of Philadelphia School of Anatomy 1832-63 He was acting assistant surgeon U S Army and consultant to group hospitals Demonstrator of Anatomy University of Pennsylvania 1863-70 Professor of clinical and demonstrative surgery University of Pennsylvania 1870 John Khea Barton professor of surgery 1871-89 Emeritus professor of surgery 1889-92 Surgeon to Philadelphia Hospital Pennsylvania Hospital Wills Eye Hospital Orthopaedic Hospital He was author of *Principles and Practice of Surgery* 3 vols 1878-81-83 *Regional Anatomy in Its Relation to Medicine and Surgery* *Researches on Organization of Blood Clot and on Repair of Fracture* and many contributions to textbooks encyclopædias and current medical literature He was president of the College of Physicians president of The American Surgical Society founder and president of the Academy of Surgery member of The American Philosophical Society and member of the Board of Directors of the Union Trust Company

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED POWELL M.D. F.R.C.S. O.A.M.

CONCERNING DYSIASIS OF WOMEN— HIERONYMUS MERCURIALIS

IN the sixteenth century obstetrics and gynaecology as well as surgery came in for a certain share of attention. Based upon the work of Soranus of Ephesus followed by that of Trotula at Salerno, Eucharius Roeslin of Wittenberg published his *Regimen* in 1531 in which he treated the podalic version first, and gestation. By this he furnished the introduction to a few men for more careful consideration and study of this phase of medicine. In England the *Regimen* was translated from the Latin into English by Richard Jones and appeared in 1540 under the title *De Partu Humano*. Subsequently practically the same work appeared under the title *Of the Birth of Man* with the name of an Englishman, Thomas Raynold, physician, as author and was the authority on obstetrics in England for a century.

By the end of the century in England were supplied the manual on obstetrics which served for teaching purposes. Switzerland was not supplied through the instrumental delivery of Jacob Rueff who published his *Ein solches lustig Trostbüchlein* in 1554 in which in addition to the purely obstetrical position there included a chapter on monstrosities. In France the subject of obstetrics was treated by Paracelsus in all things he attempted the popularized the then method and added the new. He advocated a practical version and as the first to introduce labor at term to check hemorrhage. A lesser known physician of Paris, Nicolo Rocheus also wrote a book on obstetrics. As a result expected Italy kept pace with the advances made in other parts of Europe in this department of medicine. Very little escaped the net of the great University of Padua and Jacobus Sylvius and Vittorio Trucavellio taught obstetrics and diseases of women. Ludovicus Bonacini a professor in Ferrara also taught in law in the university.

The large treatise on obstetrics in English was by an Italian during the sixteenth century as the basis based upon the lectures given by Hieronymus Mercurialis presumably when he followed Trotula as professor at Padua upon the latter death in 1568. Mercurialis wrote or lectured on nearly all the recognized departments of medicine and anatomy. There considered the subjects of obstetrics and gynaecology. The book was not written by him but like

many of the volumes attributed to him was apparently a transcription of his lectures by one of his students subsequently corrected by him. The *Leticae Dissectiones of Honei* was first published at Basel in 1582. Later it appeared as part of a general work on gynaecology published in 1586 and the volume here illustrated appeared in Venice in 1587 printed by Valgrinus. It was also published in Stassburg in 1597.

This volume was the combined work of two of Mercurialis' pupils for the title page read *Leticae Dissectiones of Honei* from the lips of Hieronymus Mercurialis recently edited by Capar Bruhin an author until lately little known. Now truly enlarged and amended with the consent of the author by Michele Clementi from the collation of many examples. With an exhaustive index of chapters and contents 1587 at Venice at the house of Felix Valgrinus. The book is thus a example of a procedure common during the sixteenth century when each professor at a law school had his Book. Well usually the person of one of his students or assistants. The amanuensis took notes on the lecturer's words and then they were then corrected by the professor and published. In this way the idea and opinion of these men too much taken up by other nations to do their writing have been handed down to us. A list of authors cited in an earlier edition of 1586 contains some hundred names and names said to convey an idea that the endeavor truly by Mercurialis in Rome had given him a great collection of the literature of the ancient and modern times. The case however the name of the author of the temporaries are lacking although Soranus, Trotula and others are noted in the names of Roeslin, Jo. Rainaldi, Rueff, and a lot of names. It could seem nevertheless that Mercurialis was at least conversant with the works of the second book of his dealing with labor, the de cibus podalic version which was at the time being popularized by Paracelsus.

The first three books deal with obstetrics treating in succession of conception, pregnancy, labor and the puerperium. The fourth book deals with diseases of the genital irregularities, menstruation, gonorrhea, the white menses (leucorrhoea), purities and other conditions both physical and pathological. A definite form of description is used throughout consisting of a description of the disease, the cause, the symptoms, the prognosis and the treatment.

DE MORBIS MVLIEBRIBVS

Prælectiones ex ore

HIERONYMI MERCVRIALIS

Iam dudum a Gaspare Baubino exceptæ,
ac paulo antea infcio autore editæ

NVNC VERO PER

MICHAELEM COLVMBVM

*Ex collatione plurium exemplarium consensu auctoris
locupletiores, & emendatiores factæ*

CVM INDICE CAPITVM ET RERV M LOCVPLETISSIMO



M D L X X V I I

Venetius, Apud Felicem Valgrisium

REVIEWS OF NEW BOOKS

THE ninth edition of Cabot's *Physical Diagnosis*¹ has been carefully revised. Analyses of further statistics have been added so that this work becomes not only a didactic presentation of physical signs but one on general differential diagnosis. In the chapter on heart murmurs the corresponding numbers of phonographic records are attached to the diagrams. This should be of great value for teaching and for ear training. In opening the discussion on auscultation the author describes the multiple Bowle's stethoscope. This suggests the multiple electrical stethoscope which by amplification and transmission of heart sounds enables an auditorium full of students to listen simultaneously with their teacher. This is a device which Doctor Cabot has used with great success in teaching

The volume continues to be the best short work in its field. It is full of characteristic refreshing denials such as "I can recognize no tricuspid murmurs and I never heard this sound." Conclusions are arrived at with originality and disregard for opinion since they are based upon first hand analysis of his own statistics. Most interesting deductions are made. Some of these are old and have long been supported by experience such as the remark that urine tests for indican, urea sulphates and phosphates give the appearance of accuracy, and scientific method in diagnosis is but not the reality. Other statements such as "I have never seen any evidence that excessive muscular work is by itself capable of causing cardiac hypertrophy and dilatation" tend to be supported by the most recent physiological work.

Thus for extent of material presented and for stimulating observation this volume continues to be one worth repeated study. PAUL STARR

IN this interesting volume containing thirty seven of the Practical Lectures delivered before the Kings County Medical Society, men of prominence in the various specialties have been selected to present subjects most likely to be of value to the doctor in general practice.

Several of the lectures have particular interest. George W. Crile's "The Surgical Treatment of the Thyroid Gland" is based on his experience in performing 13,988 operations upon the thyroid gland. The United States Public Health Service is explained by Surgeon General Hugh S. Cumming. The Doctor in Court is full of interest and instruction for those unfortunate enough to have to go there.

Haven Emerson gives his reasons for advocating periodical health examinations John H. Gibbon

in his *Common Sense in the Treatment of Fractures* very properly includes commendation of the massage methods of Lucas Championniere

Inherited Syphilis is well covered Foster Kennedy contributes a lecture on Fits Frank H. Lahey discusses the Varieties and Treatment of Gout George M. Mackee devotes 64 pages to the More Common Diseases of the Skin John O. Polak lectures on Toxæmias of Pregnancy

The subjects are handled in a somewhat elementary manner but the eminence of most of the contributors assures an interesting presentation.

FREDERICK CHRIST PHER

WOLBARST has compiled a most valuable treatise on *Gono- or al Infection in the Male*.² He states that the book is designed primarily to guide general practitioner in the proper recognition and management of the disease and its troublesome complications. Specialists and medical students might advantageously familiarize themselves with this text. The author has kept his subject matter completely up to date and his method of presentation is concise and easy to follow. Diagnosis and treatment have been classified according to the pathological involvement of the various anatomical structures.

A discussion on the proof of cure constitutes an interesting chapter. A final chapter by McDonagh of London in which he expresses his view on gonorrhea accentuates the divergence of opinion in the two countries.

VINCENT J. O'CONNOR

VINCENT J O CONOR

THE author of the book presents a very fine work in German on the subject of X ray diagnosis in surgery.⁴ He states that the material for the book was obtained in the University of Göttingen X ray Department with the aid of the Pathological Department as well as the medical and surgical clinics of that institution.

The book is a splendid presentation of the subject well written and exceedingly well illustrated. It is an example of careful work in preparation of a difficult subject. The book may be recommended to any physician interested in X-ray particularly those who can read the German text. The many illustrations with which the book abounds are of such superior quality and demonstrate pathological changes so well that very little reading matter is required to explain the X-ray features. The volume is large and the subject is treated at length in a thorough manner.

EDWARD S. BLAIN

EDWARD S. BLAIRF

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AS Sir Arthur Keith ends his foreword *Healthy Growth* is a most interesting book for all who are concerned with education—medical officers, headmasters, teachers, parents, educational authorities, and above all, statesmen who have the welfare of the nation at heart. It consists of several chapters on anthropometry in relation to educational progress, adaptation and development as indicated by entrance examinations and school work, technical chapters on special methods and physiology, consideration of overwork, over pressure, and the ailing school child, and a correlation between the mental and physical activity of growing boys. It has five appendices devoted to statistical methods. It is an authoritative fundamental work in this most important field.

PAUL STARR

PRESENT clinical knowledge is summarized by Coope in his book on the diagnosis of pancreatic disease. The book consists of two main parts—the first is a brief but helpful statement of anatomy, physiology, and clinical picture; the second is an honest and somewhat disillusioning discussion of functional tests under the heading of attempts to detect failure of discharge of pancreatic juice into the Duodenum. Intubation as a means of obtaining pancreatic secretion is described with a simple method for detecting lipase. A careful discussion of tests for ferments in the stool is given, the conclusion of which is that true steatorrhea on a controlled diet is the test for pancreatic deficiency, while true steatorrhea or butter stools are rare and lesser amounts of fat in the stool may be due to other causes. The whole question is

carefully examined. The importance of stool examinations on controlled diet and the use of indicators in the feces to control the time of transit through the gut are emphasized. The work is not impressive by reason of size but because of honest analysis. It is to be highly recommended as indicating methods of attack in a difficult and little known field.

PAUL STARR

THE new edition of this important *Treatise on Orthopedic Surgery* brings it fully up to date and maintains its position as the best modern text book in this field. The subject matter is well and tersely presented and includes all information essential to the practitioner or special worker. The descriptions of the most valuable original contributions of the distinguished author, namely, the bloodless reduction of fracture of the femoral neck, the open reconstruction operation upon the hip-joint, and the astraglectomy and backward displacement of the foot, might well receive more space and better illustrations. The second sentence of the first chapter describing Pott's disease is unsatisfactory and should be rewritten.

The conclusion called osteochondritis dissecans by Koenig is still a stumbling block to the compositor. In the 17th edition of Whitman's book it was printed as "Dissecans" and in the present edition it appears as "Dissecan".

Koenig's original observation was published in the *Deutsche Zeitschrift für Chirurgie*, December 16, 1887, and refers to the condition as a *dissectierende osteochondritis* or *osteochondritis dissecans*.

In many other instances the proof reading has not been done in a manner commensurate with the importance of this textbook, which fact however does not detract from the intrinsic value of the work.

E. VAN WYKES

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BOOKS RECEIVED

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J. S. f. Hall. und Ludw. h. t. z. L. f. r. u. n. g. 39. und 40.
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NUMBER 3

CANCER OF THE LARYNX

SYMPTOMATOLOGY, DIAGNOSIS AND TREATMENT¹

By GABRIEL TUCKER, M.D., PHILADELPHIA

A. ocia t P f f B h py d (Esoph g sc py G d te School f Med U ty f P y) A oc t B h sc py d Cl ph g py j ff M d Coll g

IT would seem a platitude to say that the early recognition of cancer in any part of the body is of the greatest importance in its cure. The repetition of this statement is justified however when we consider that in intrinsic cancer of the larynx early diagnosis offers a lasting cure of from 70 to 80 per cent. This is a much higher percentage of cure than can be obtained in cancer in any other location in the body. It has been shown by Cuneo that the richly developed lymphatics of the larynx form a network of their own which empties into small glands on either side and does not anastomose with the neighboring lymphatics. The slow metastasis with early diagnosis makes possible the high rate of cure in intrinsic cancer of the larynx. It is therefore imperative that every physician and especially every otolaryngologist recognize the symptoms, appearances and means available for the accurate diagnosis of incipient cancer of the larynx.

The classical symptoms as formerly taught—aphonia, dysphagia, pain in the ear, salivation, dyspnea, hemorrhage, fetor, glandular involvement, emaciation and cachexia—occur as evidence of far advanced disease but little attention has been paid to the earliest symptoms of involvement, those for which the physician should be on the alert. The first symptoms are persistent local discomfort, persistent hoarseness or the two combined according to

the location of the lesion in the larynx. Persistent hoarseness and discomfort in the region of the larynx occurring in an adult of any age should have the skilled attention of the otolaryngologist.

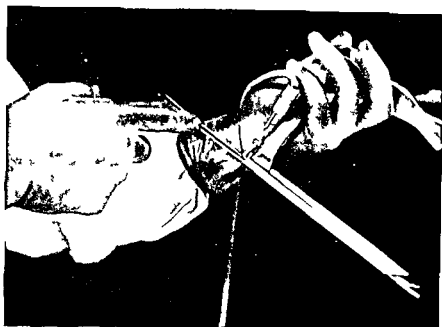
AGE

Cancer of the larynx occurs rarely under the age of 40 years but there have been cases reported of intrinsic cancer at 16 and 18 years of age and of extrinsic cancer of the larynx at 23 and 4 years of age (10). Only yesterday in our clinic at the University Hospital, the histological examination of a specimen removed from an extensive intrinsic ulceration of the larynx in a man 37 years of age was reported as epithelioma by Dr. Herbert Fox. The patient had been hoarse for 9 months and during the past 9 months had only a whispered voice. In 100 selected cases from the services of Dr. Chevalier Jackson and Dr. Fielding O. Lewis in which hoarseness was a symptom, Dr. Austin T. Smith found that the average time from the beginning of hoarseness until a diagnosis was made was 11½ months. Many of these cases were far advanced. Many had been treated under a diagnosis of chronic laryngitis without even an attempted mirror examination of the larynx.

CLASSIFICATION

Cancer of the larynx was classified clinically by Krishaber into intrinsic, extrinsic and

¹ R d lef reth Med l Soc ty f th State f N th C l Ap l 9 9 7 D h m N th Ca l a.



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mixed. The latter class included those cases in which the lesion was both intrinsic and extrinsic. These cases were found to present the classical symptoms already enumerated. The intrinsic group included all cancers arising from the cord, ventricular band, interarytenoid region and the subglottic area. Chevalier Jackson further subdivides this group into the anterior intrinsic, including the anterior two-thirds of the larynx, and the posterior intrinsic, in cases in which the cancer arises in the posterior third of the larynx (4). The earliest symptom in the anterior intrinsic group is

hoarseness in the posterior intrinsic group, local discomfort and hoarseness.

The extrinsic group includes those cancers arising from the epiglottis, arytenoid, aryepiglottic fold, the laryngeal surface of the pyriform sinus and the pharyngeal surface of the cricoid cartilage. The earliest symptom in this group are local discomfort and dysphagia.

SITE

Cancer may involve any part of the larynx; epithelioma is the most frequent form; sarcoma and medullary cancer are rare. Glandular carcinoma most frequently involves the epiglottis. Contrary to the view of Virchow and Semm who held that benign growths most frequently invade the anterior two-thirds of the larynx and malignant growths the posterior third, Sir St. Clair Thomson has shown that the anterior two-thirds is the most frequent site of the primary lesion in cancer (11). This area corresponds to that area involved in the anterior intrinsic group of Chevalier Jackson and that portion of the larynx in which lymphatic drainage occurs late. The fact is established by Sir St. Clair Thomson that the anterior two-thirds of the larynx is the most fre-

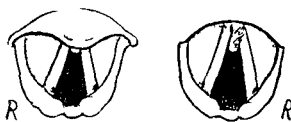


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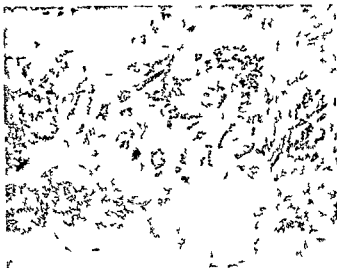


Fig. 3. Photomicrograph of tissue removed from the larynx illustrated in Figure 2b. Twenty-four hours after the specimen was taken Herbert Fox reported squamous cell epithelioma.

quent site of cancer is of the utmost importance because with early diagnosis this site is the most favorable for cure.

LOCAL APPEARANCES

Local appearances vary according to the location and stage of advancement of the growth, the presence of superimposed inflammatory reaction and ulceration. Seldom is the appearance so characteristic as to be conclusive. Many types have been described as follows by Sir St. Clair Thomson (10):

1. Persistent congestion and thickening of the cord.

A definite tumor resembling papilloma, fibroma or angioma, and an irregular infiltration difficult to distinguish from tuberculosis and syphilis.

3. A limited infiltration cupped or retracted in appearance.

4. A defined tumor, single sessile, white and reddish gray, and warty looking.

5. A fringe-like border, white in color, giving the cord an irregular appearance.

6. In the extrinsic variety, a dusky red uniform swelling, which is generally a fleshy color with an uneven surface.

7. On the epiglottis, a cancerous growth is irregular, grayish white, dusky red or dirty white in early ulceration.

Local fixation of the part involved indicates deep infiltration and advancement of the le-



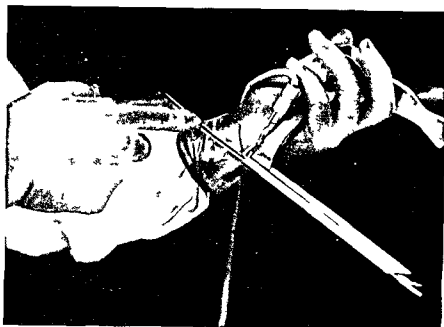
Fig. 4. Tissue removed at larynx of sure (actual size). Within 48 hours after removal of the specimen for biopsy a wide margin of normal mucosa surrounds the growth. The patient is now well with a good voice 16 months following operation. Arrow indicates anterior commissure (Crawford).

sion. In many cases we have found on biopsy the local lesion cancerous when there was no local fixation on mirror examination.

Considering then the wide variation in appearance on mirror examination and the many and variable factors in the production of these appearances, the welfare of the patient demands that a method of certain diagnosis be employed early before the disease has extended and the chance for operative cure is lost.

DIAGNOSIS

Given a case of ulceration of the larynx in an adult, the 3 etiological conditions to be considered are tuberculosis, syphilis, and malignancy. It is generally agreed that tuberculosis of the larynx for all practical diagnostic considerations is never primary (9). Then the finding of an ulcerative lesion of the larynx with an appearance suggestive of tuberculosis is with the finding of positive evidence of a pulmonary lesion is very strong presumptive evidence of laryngeal tuberculosis. In syphilis of the larynx, the positive serological reaction and the evidence of syphilitic disease in other organs, the favorable effect of a therapeutic test with antisyphilitic medication on the laryngeal ulceration, and the suggestive appearance on mirror examination are strong presumptive evidence of syphilitic ulceration of the larynx. It must be remembered, however, that malignant disease of the larynx, particularly in a syphilitic subject, may respond favorably for a time to antiluetic therapy. It is also well to remember that an acute oedema of the larynx may be precipitated by the



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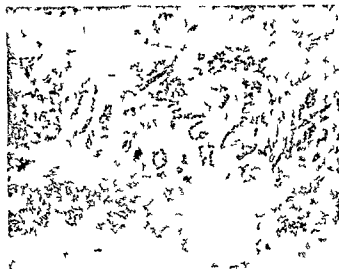


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Fig. 4. Tissue removed at laryngotomy (actual size). Within 48 hours after removal of the specimen for biopsy. A wide margin of normal mucosa surrounds the growth. The patient is now well with a good voice 16 months following operation. Arrow indicates anterior commissure (Crawford).

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Given a case of ulceration of the larynx in an adult, the 3 etiological conditions to be considered are tuberculosis, syphilis, and malignancy. It is generally agreed that tuberculosis of the larynx for all practical diagnostic considerations is never primary (9). Then the finding of an ulcerative lesion of the larynx with an appearance suggestive of tuberculosis, with the finding of positive evidence of a pulmonary lesion, is very strong presumptive evidence of laryngeal tuberculosis. In syphilis of the larynx, the positive serological reaction and the evidence of syphilitic disease in other organs, the favorable effect of a therapeutic test with antisyphilitic medication on the laryngeal ulceration, and the suggestive appearance on mirror examination are strong presumptive evidence of syphilitic ulceration of the larynx. It must be remembered, however, that malignant disease of the larynx, particularly in a syphilitic subject, may respond favorably for a time to antisyphilitic therapy. It is also well to remember that an acute edema of the larynx may be precipitated by the



Fig 5 Photomicrograph of the larynx removed from the patient with a pharyngeal ulcer and finally removed by the pharyngeal ulcer (Cr. 1 d)

administration of potassium iodide to a patient with an ulcerative lesion of the larynx. A provisional diagnosis of malignancy of the larynx can then be made in an adult patient when all evidences of tuberculosis or lues are negative and the appearances are suggestive of cancer remembering, however that malignancy may coexist with phibis or tuberculois or that it may occur in a tuberculous or a yphilitic subject.

Every case should be thoroughly studied a positive diagnosis should not be made on mirror examination alone. That uncanny diagnostic sixth sense which does not depend upon the teachings or the literature for its inspiration so well evaluated by William V. Mullin in *Diagnostic Limitation in Laryngology* (7) and so adequately defined by Dr D. Bryon Delavan as a subconscious reasoning based upon long experience of many closely observed cases (7-2) should be developed by every laryngologist for as Dr Delavan further says "The beginner does not have the instinct for diagnosis. The man of long experience may acquire it."

In addition to this in every case of early cancer of the larynx the conclusive diagnostic step should be biopsy. If biopsy is negative for cancer the specimen removed may afford



Fig 6 Photomicrograph of the larynx removed from the patient with a pharyngeal ulcer and finally removed by the pharyngeal ulcer (Cr. 1 d)

evidence of some other infectious or neoplastic condition of the larynx either on culture or histological examination. If negative repeated specimens should be taken at proper intervals and under proper aseptic precautions until conclusive evidence is obtained. By the use of the Jackson anterior commissure laryngoscope under local anesthesia with only slight discomfort to the patient a specimen can be removed with accuracy from any portion of the larynx that is desired (Figs 1 and 2). A histological report can be obtained by the quick method in 4 hours (Fig. 3) and if the growth be malignant the surgical procedure adequate for the removal of the growth can be instituted within 48 hours (Fig. 4). Dr Baxter L. Crawford states "The examination of a number of the larynges removed by Doctor Lewis at laryngectomy showed no evidence whatever of metastasis as the result of biopsy although in many instances the patient had refused laryngectomy for several months following a positive report from biopsy (1)."

In the examination of the larynx with the mirror we see only the surface of the lesion. In early cancer the appearances are not characteristic and the important thing to know is



Fig. 7 Photomicrograph of tissue removed from the larynx of a man aged 55 years showing mucous membrane markedly thickened epithelium hyperplastic and the submucous tissue markedly inflamed. There is marked hyperplasia of the epithelium suspicious of malignancy but no definite evidence of malignancy (Crawford)



Fig. 8 Photomicrograph of tissue removed 3 years later from the same larynx as in Figure 7 showing mucous membrane ulcerated epithelium markedly hyperplastic and definite evidence of infiltration into the deeper structures. The infiltrating epithelium shows considerable differentiation and many mitotic figures. There is marked inflammatory reaction of submucous tissue. Squamous cell epithelioma (Crawford)

what the deeper cells are doing. This can be determined only by biopsy. Biopsy reveals another very important class of cases. The lesion in this class was described by Chevalier Jackson and designated clinically as "precancerous" (3). Time will not permit a discussion of the evidences presented by Doctor Jackson of the precancerous conditions but the evidence is conclusive that cancer develops following non malignant lesions in the larynx. Sir St. Clair Thomson quoting Semon states: "A malignant degeneration of a benign neoplasm may occur" (10). Our pathologists often report to us that there is a suspicion of malignancy in the specimen of tissue examined. Chevalier Jackson quotes Dr. James Ewing after his examination of one of these specimens as saying: "This is the stage in which to treat cancer of the larynx, not after it gets well advanced" (3).

From our tabulation of the last 50 cases of cancer of the larynx at the Chevalier Jackson Bronchoscopic Clinics, I wish to report 2 cases from the group in which existed a non malignant lesion which seemed to be an etiological factor in the later development of cancer.

CASE 1. A woman 3 years of age presented a lesion of the larynx, a specimen of which on histological examination showed papilloma and chronic infiltrative laryngitis (Fig. 5). Five years later a specimen from the same patient showed squamous cell epithelioma (Fig. 6). The symptoms of laryngeal involvement persisted from the time of the first examination to the second (Pathologic Reports by Dr. Baxter L. Crawford).

CASE 2. A specimen removed from an ulcerative lesion of the larynx in a man 55 years of age in March 1914 showed marked hyperplasia of the epithelium with suspicion of malignancy but not definitely malignant as reported by Doctor Crawford (Fig. 7). Operative removal of the lesion was advised at this time but the patient refused and on his return February 1921, the specimen removed at biopsy showed definitely squamous cell epithelioma (Fig. 8).

TREATMENT

Adequate surgical removal is the only treatment worthy of consideration with the hope of cure of cancer of the larynx. The removal of an intrinsic growth by intralaryngeal surgery is not advisable because of the uncertainty of complete removal.

Laryngofissure. After early diagnosis laryngofissure will cure 80 per cent of the anterior

intrinsic cause and will give an adequate voice with no operative mortality without a mutilating operation. Recurrences following laryngotomy may be amenable to reoperation by laryngohisture and are always amenable to complete laryngectomy if the patient has been kept under postoperative observation. The patients should be examined by the surgeon who performed the laryngohisture at least every month for the first year.

Complete laryngectomy according to John Edmund Mackenty should be done in all intrinsic cases in which there is extensive involvement (6). Dr Fielding O. Lewis feels that laryngectomy may also be indicated in extensive cases in which the lesion is extrinsic or mixed (5) and in other extrinsic varieties subhyoidpharyngotomy and lateral pharyngotomy.

The use of radium and X-ray is now generally conceded to have no place in the treatment of cancer of the larynx except in some cases as postoperative radiation after laryngohisture or laryngectomy to prevent glandular invasion (1). It may be used also in those cases of cancer of the larynx which are not amenable to surgery because of the location or extent of the growth. Dr Henry K. Pancoast from his enormous experience at his clinics at the Philadelphia General and the University of Pennsylvania Hospitals states: "I no longer use radium in the treatment of laryngeal cancer except in special cases. Cancer of the larynx is not suitable for radium therapy first because of the resistant nature of the squamous cell carcinoma which is the type most often found second because of the tendency to necrosis of the laryngeal cartilage after the intensive radiation necessary third because of the frequently inaccessible position of the growth" (8).

Tracheotomy Tracheotomy for the relief of dyspnea with palliative radiation may be advisable for advanced cases.

CONCLUSIONS

1. The earliest symptoms of cancer of the larynx are hoarseness and local discomfort. A persistence of the symptoms in an adult should place the patient under suspicion of cancer and he should be kept under the

observation of an expert laryngologist until a definite diagnosis is made. Mirror examination while the most important method for study is not conclusive and should be supplemented by general examination X-ray examination serological studies direct laryngoscopy and biopsy to exclude cancer definitely in a suspicious case. Doctor Jackson says:

Every adult patient with hoarseness should be considered as possibly cancerous until proven otherwise by every means we possess.

2. Early diagnosis will permit a cure by laryngohisture in about 80 per cent of cases.

3. Biopsy by means of the direct laryngoscope should give a positive specimen in every case of cancer of the larynx. But if the specimen is inconclusive or negative it should be repeated while any suspicion of cancer remains. In the hundreds of cases of cancer of the larynx in which a specimen has been removed for histological examination at the Bronchoscopic Clinic we have never seen any evidence of metastasis as the result of biopsy.

4. Laryngectomy subhyoidpharyngotomy and lateral pharyngotomy will cure a good percentage of the extensive intrinsic and extrinsic cases.

5. In inoperable cancer of the larynx tracheotomy and palliative radiation may be advisable.

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SQUAMOUS EPITHELIUM IN THE ENDOMETRIUM IN BENIGN AND MALIGNANT CONDITIONS

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F mth D p tm t fOb t t lGy lGy St f dU tyS hool f M d

SQUAMOUS epithelium in the uterine cavity has been noted so frequently that it has given rise to an extensive literature the main interest in its occurrence being centered on its relation to malignancy. A review of the instances which have been reported shows that all of the case may be grouped into three categories first are the cases with a definitely benign process second those with a malignant condition and finally a small group presenting certain findings which have given rise to controversy regarding their exact significance.

The normal cylindrical epithelium of the uterus is rather frequently replaced by a type of stratified squamous epithelium of a purely benign character and Veit (43) has given this substitution the name of epidermidization. This change is found principally on the cervix during the healing of erosions and in inflammatory conditions (Fluhmann 8) and also on the surface of cervical mucous polypi (Fluhmann 9). In the endometrium it has been described in a variety of lesions Zeller (48) in 1885 on the basis of observations made on 63 patients stated that in chronic endometritis the cylindrical epithelium of the corpus or cervix uteri is very frequently replaced by stratified squamous epithelium. He maintained that this new tissue with its basal cylindrical cells its numerous transitional forms and its superficial cells without nuclei is similar to that of the vagina and that cornification may occur in its more superficial layers. Considerable interest was aroused by Zeller's statements concerning the so called ichthyosis uteri.

Subsequent workers although they found squamous epithelium in a few cases of endometritis have failed to substantiate Zeller's statement as to the frequency of this lesion (Ruge and Gebhard 13, Ries 34) and it has been suggested that there was some error in his microscopic technique. Zimmermann (50) has recently described a case in which he

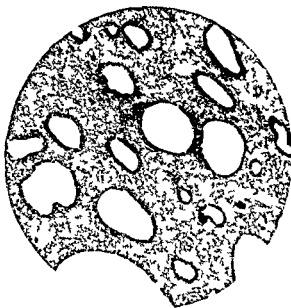
found on the surface of the endometrium a type of stratified epithelium resembling squamous epithelium. He interpreted his findings as representing a degeneration of cylindrical cells rather than a metaplastic change and stated that this explanation might account for the frequent mention of ichthyosis uteri by some of the early authors.

At present the consensus of opinion seems to favor the belief that squamous epithelium is found in the endometrium only in exceptional instances. However it has been described by Klein (23) and Sitzenfrey (41) and Schottlaender (39) in a study of 579 specimens found so called metaplastic changes 14 times in the body of the uterus. Werth (44) states that during regeneration of the uterine mucosa following curettage a tissue resembling squamous epithelium may be found. Hengge (15) believes that it may occur following pregnancy malignancy or tuberculosis. Bondi (5) and Schneider (38) found squamous epithelium in cases of pyometra and Alterthum (1) noted similar changes with formations resembling canceroid pearls in a case of tuberculous of the endometrium. Mainzer (4) reports 4 cases in which he found metaplastic changes in the uterus following intra uterine applications of formalin. Franke (10) and Ries (34) describe epidermidization of the endometrium in chronic inversion of the uterus and Herxheimer (16) reports the finding of squamous epithelium on the surface of an endometrial polyp projecting into the cervical canal.

The condition has also been produced experimentally. Dietrich (5) caused a retention of products of conception in pregnant guinea pigs by ligating one uterine horn and removing the fetus. Two months later the tissues were examined and he was able to demonstrate a metaplasia of cylindrical to squamous epithelium. Recently Wolbach and Howe (47) conducted a series of histological studies on a number of rats which had



I g r l Sq am u p thel um l m ldl thi d f



I g r Sh hyp rpl f th d met um Lo

been fed on a diet lacking fat soluble A vitamin and found keratinization of the uterine cavity.

It is of considerable importance particularly in the question of etiology that such changes have been noted in the uteri of newborn and young children. Meyer (28) found areas showing a stratification of cells in the endometrium of a newborn. There were from 4 to 8 rows of cells; the lowermost were cylindrical in shape; the next were cubical and in the most superficial layer the cells were flat and resembled endothelium. Friedlaender (1) found islands of squamous epithelium in the uterine cavity of a child 3 years old. More recently Wilson and DuBois (46) described the findings in a child 5 months old who had died from a deficiency of fat soluble A vitamin and found epidermalization of the endometrium in the region of the fundus. Finally, Natanson (29) studied a series of cases and came to the conclusion that squamous epithelium occurred in the corpus uteri in 10 per cent of children up to the age of 2 years and that as a rule it tended to disappear during the further development of the uterus.

Squamous epithelium occurring in malignant conditions of the corpus uteri has been discussed many times but still offers numer-

ous unsolved problems particularly regarding its origin and development. It is important to remember however that squamous epithelium does not always have the same significance and that the cases may be divided into 4 distinct groups.

1 Squamous epithelium occurring as a metaplastic process in an adenomatous carcinoma of the uterine cavity.

Squamous cell carcinoma coexisting with an adenocarcinoma.

3 Squamous cell carcinoma of the corpus secondary to a similar growth of the cervix uteri.

4 Primary squamous cell carcinoma of the uterine body.

The first group represents a large number of cases and numerous instances have been reported in the literature for example by Frank (11), Hirschmann (18), Zimmermann (49). The active process is a malignant adenomatous growth and the squamous epithelium does not take any part in the destructive and invasive lesion. Hirschmann states that it is of frequent occurrence in glandular cancers of the corpus uteri and not only is it found in primary growths but several instances have been described in which the malignant tumor in the uterus was a



Fig 3 Island of squamous epithelium in hyperplastic endometrium 10x power



Fig 4 Island of squamous epithelium in hyperplastic endometrium 20x power

metastasis of an ovarian cancer (Zimmermann 49 Hunziker 20)

The exact mechanism of this metaplastic change has given rise to considerable discussion and there has been some question as to whether the metaplasia occurs from carcinomatous cells or from mature cylindrical epithelium. It has even been suggested that we are not dealing with a metaplastic process in fully developed cells but that both types arise from an embryonic tissue which carries the potentialities of differentiating into either cylindrical or squamous epithelium. Meyer (26) believes that it was definitely established that metaplasia could occur in cells at the surface but that when the process was found deep in glands some other factor must be found to account for it. This has been refuted however by Herxheimer (16) who maintains that no sharp distinction should be drawn between surface and glandular epithelium since they belong together genetically. Hirschmann also states that metaplasia occurs in both. Zimmermann (49) in a more recent review states that a true metaplasia must be considered in some instances but that in the majority of the cases which he has studied the findings were accounted for by a degenerative change in

cancerous cells both in glands and at the surface simulating squamous epithelium. This possibility was also advanced by Keith (22) in 1905 in connection with a case which he reported.

In the second group of this classification is found a rare type of tumor in which an adenocarcinoma and a squamous cell cancer co-exist in the same uterus. A considerable number of these double cancers were described by early authors but it is probable that many of the cases really belonged in our first group and that the squamous epithelium simply represented a metaplastic process. Hirschmann (18) claims that the theory of the origin of these tumors from two different matrices must be abandoned. However, whether the squamous cell tumor represents a primary growth in the uterus or results from cylindrical cells which have undergone a metaplastic change apparently *bona fide* cases have been described in which cells of both types were found taking an active part in the destructive lesion (Kaufmann 21 Strong 42).

In the third group which includes those cases of squamous cell cancer of the endometrium appearing as a metastasis or direct extension from a similar growth in the cervix



F I H h p pl t m r g r t h f t f l l



F 6 H h l pl t m r r a p l f n t o f l l

we find the greatest number of cases. In 1911 Maunaf Heurlin (35) collected numerous instances from the literature. This group is of little interest except in regards the various ways in which the condition may occur. In the first place the cancer cell may be disseminated along the lymphatics in a retrograde manner and specimens have been described in which numerous small foci have been found scattered throughout the uterus. The cancer cell may also proceed by direct extension from the original tumor as a destructive process and there is a special form in which the growth remains superficial and spreads over the endometrium. Ruge has given such a condition the name of *ulcer guss* cancer. Pfannenstiel (31) has mentioned the possibility of direct implantation on the endometrium from a cervical growth either spontaneously or by instrumentation.

The fourth group of this classification is of great importance for it includes the primary squamous celled carcinoma of the uterine body. This condition is rare and only a few of the cases that have been described have been accepted by subsequent workers as being sufficiently confirmed.

It would seem that three requirements must be fulfilled before the diagnosis can be

considered as absolutely established. First there must be no sign of a coexisting cylindrical cell cancer. Second there must be no connection between the growth and the stratified squamous epithelium of the cervix and third the cervix must have been carefully examined to eliminate an original growth in that organ. The requirements necessarily cast doubt on a number of instances which have been reported in which there was a small growth in the cervix and a larger one in the fundus and in which the interpretation has been that the cervical tumor occurred as secondary to one in the uterine cavity for example in the case of Schauta (36) and Tiering (32). Although it is perfectly conceivable that this might occur it is so much more likely that the primary growth lies in the cervix that these cases must be questioned. The fact that the intra uterine tumor is more advanced than the cervical growth is no proof as there are many examples of a metastatic tumor exceeding the primary lesion in size.

In 1911 Maunaf Heurlin (35) reported on this subject very thoroughly, reported a case of his own and only accepted as bona fide 5 instances of primary squamous celled carcinoma of the corpus uteri namely the case of

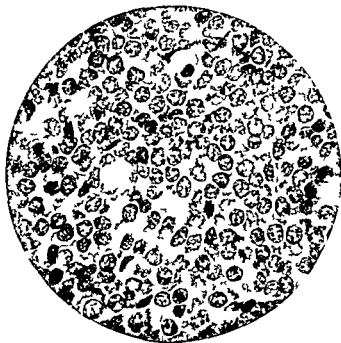


Fig 7 Photomicrograph showing regularity of cell arrangement in figures 5 and 6. Magnification under oil immersion lens



Fig 8 High power photomicrograph from an area seen in figure 3 showing tendency of some of the cells to differentiate further into squamous epithelium

Schauta and Piering (36, 37) Gebhard (13) Flaischlen (7) Gessner (14) and Schauenstein (35). In 1909 Cullen (4) considered the cases of Flaischlen and Gebhard as authentic and felt that other instances he had met in the literature (including that of Schauta and Piering) were of a doubtful nature. However specimens which seem to fulfill the requirements mentioned have also been described by Batchelor (2) and Norris (30). Since 1911 3 papers purporting to report similar cases have been published. Hirsch (17) described 3 cases but gave incomplete information and did not mention the findings in the cervix. Williamson and Abercrombie (43) report a case accompanying inversion of the uterus but also fail to give the findings in the cervix. Furthermore the patient had been treated with radium before the specimen was obtained. Schmitt (37) describes a case which is apparently authentic but which was complicated by metastases in the vagina and vulva. The portion of the cervix which was removed at operation was not available for examination.

In 1921 R. Meyer (27) described very unusual findings in the endometrium of a patient 42 years of age. The endometrium

seemed to be normal in appearance except for two areas of hyperplastic mucosa which showed remarkable collections of cells associated with the glands. These cells with their stratification, their polygonal shape and round nuclei suggested squamous epithelium although the cells were not differentiated into definite layers. In some places the cells occurred beneath the cylindrical epithelium grew into the lumina of the glands and partly or completely filled them. They also extended into the surrounding tissues but as well defined nests of cells and not as a destructive growth. Meyer felt that he was dealing with a benign process although he advised keeping the patient under close observation.

Similar findings have been reported by 4 other authors 3 of whom considered them as carcinoma. Lingelhorn (6) found these cellular masses in a uterine polyp from a woman 23 years of age and diagnosed it as an adenocarcinoma. Sitzenfrey (40) described identical cells associated with an adenometritis uteri in a woman 43 years old and also held that it was of a malignant character. Meyer however had an opportunity of studying sections from both these cases and

states that the findings corresponded to those he described. Polano (33) saw the same changes in a polypoid tumor of the uterus from a patient 43 years of age and interpreted them as an adenomyoma carcinomatosum. The case of Hunziker (20) is of particular interest because he considered it to have a benign nature. The patient had no treatment beyond a diagnostic curettage. In a later communication to Meyer Hunziker states that the patient had remained well for 12 years.

The following case from the Stanford Gynecological Service presents what I believe to be a condition similar to that already described.

Miss A. D., age 34 years, nullipara, admitted to hospital March 4, 1927. She complained of intermittent vaginal bleeding which had persisted for 8 years. The personal and family history was inconsequential. The menses began at 14 years, were regular until onset of present illness with moderate flow, backache and occasional abdominal pain. During the past 8 years patient had had intermittent attacks of profuse vaginal bleeding. At first this occurred only at menstrual periods but later it became irregular in appearance and at the time of admission had been constant for 2 months. She had had 3 curtages by outside physicians but the only produced temporary relief. No pathologic reports of the curtages could be obtained.

Physical examination. Temperature 98.8 degrees. Pulse 84. Patient was slightly pale, well developed and well nourished. History of about stated age. No marked abnormalities were noted in the general examination. Blood pressure 114/80.

Laboratory examination. Urinalysis negative. Red blood cells 4,200,000; hemoglobin 75 per cent (Sahl); white blood cells 10,000; bleeding time 5 minutes; coagulation time 6 minutes.

Pelvic examination. The vulva as closed the outlet nulliparous. The perineum was firm. Examination of Skene's glands was negative. The left Bartholin's gland was palpable. The cervix was slightly hypertrophied with a small laceration on the right side. The fundus uteri was slightly enlarged forward, freely movable, smooth and of firm consistency. The adnexa were negative. Speculum examination showed blood oozing from external os, erosion of cervix.

Operation. March 25, 1927. A midline incision was used. Exploration of the pelvis showed a lightly enlarged uterus in good position. The left tube and ovary were grossly normal. The right ovary contained a cyst the size of a walnut. The appendix was about the size of a small finger and markedly injected. Gall bladder was rather tense, no stones were felt. Operation consisted in (1)

total hysterectomy (2) right salpingo-oophorectomy (3) appendectomy. After an uneventful recovery the patient left the hospital on April 9, 1927.

Pathological examination. The appendix was normal. A follicular cyst was found in right ovary with marked increase of ovarian blood vessels. The right tube showed chronic inflammatory changes. The uterus measured 8 by 6 by 5 centimeters. It was of a firm consistency. The cervix showed a small tear on the right side and there was an erosion of the external os. The endometrium of the lower half of the uterine cavity was grossly normal but in the region of the fundus it was considerably thickened and near the right cornu there were several soft, irregular polypoid projections.

Microscopic examination. Sections of the cervix showed chronic inflammatory changes in the region of the external os. The cylindrical epithelium of the cervical canal was replaced by normal squamous epithelium almost to the internal os (Fig. 1). Various stages of epidermalization on not only at the surface but also in a few of the glands were seen. No evidence of malignancy was found.

Endometrium. Sections of the endometrium were taken from every part of the uterus. The general picture found was that of hyperplasia of the endometrium (Fig. 2) and the hyperplasia was marked in the tissue obtained from the region of the fundus. Three sections however showed unusual collections of cells (Figs. 3 and 4). One of these sections was from the lower part of the uterus just above the internal os, another from the lateral wall near the right cornu, while the third was of polypoid endometrium from the fundus. The cells occurred as well defined rounded or oval nests. They were seen to arise from beneath the cylindrical epithelium of the glands and to grow either to the lumen of the glands, which they completely filled in some instances or to protrude to the surrounding tissues. Isolated nests were seen but serial sections showed that they originated from glandular epithelium. The interstitial tissue in the areas as evidenced suggesting that it had been compressed by the element. The individual cell were polygonal in shape and showed constant regularity in shape and size (Fig. 5, 6 and 7). The nuclei were small round and showed no striking abnormalities. There were no mitotic figures. In one area a few cells were of somewhat larger size and were similar to those usually seen in the middle layer of squamous epithelium (Fig. 8) but the general appearance of the masses suggested collections of cells resembling the basal cell of normal squamous epithelium or those seen in various transitional phases of epidermalization (Fluhmann 8). There was no apparent differentiation into layers as in squamous epithelium and no concentric figures suggesting formation of canceroid pearl could be found. The surface epithelium of the endometrium was intact and the abnormal cellular masses were seen mostly in the middle layer of the mucosa. At no place was there any suggestion of invasion of the musculature.

The differential diagnosis in this case is difficult to make with any degree of certainty and presents several very interesting problems. The first question to be answered is whether we are dealing with a malignant condition or with a benign change accompanying a hyperplasia of the endometrium. Of the authors who have previously discussed the subject three have diagnosed carcinoma and two have favored the view that it is an innocent process. Hunziker's patient remained alive and well for 1 year following a simple curettage and this may be taken as fairly good evidence that it was not a cancerous lesion although there is the remote possibility that an early cancer had been completely removed by the curette. It is also important to note that there has been no demonstrable involvement of the uterine musculature the lesion being definitely localized in the endometrium. A study of the individual cells shows none of the characteristics such as mitotic figures and staining irregularities usually assigned to malignant tissue. Engelhorn, Polano and Sitzenfrey base their conception that it is cancerous on the fact that there is an extension of the cells into the interstitial tissue of the endometrium and maintain that this is a lymphatic propagation. As Meyer points out however this is not *per se* proof that the growth is malignant. The cells are consistently arranged in small nests and do not branch out into the interstitial tissue as does a destructive lesion. Meyer considers it to be an extension similar to that seen in the growth of a simple cyst or a fibromyoma that is it pushes the surrounding tissues out of the way without definite invasion and destruction. Meyer also examined the sections from Sitzenfrey and failed to find certain evidence of a lymphatic propagation while Maunu and Heurlin (5) doubts that Polano's case should be considered as a carcinoma.

I am convinced that the findings in our patient are of a benign nature but have to acknowledge that a positive statement is almost impossible owing to the few observations available and our lack of information in regard to the subsequent history. If then

the condition is not malignant what is the significance of the abnormal cells? Hunziker and Meyer consider them as squamous epithelium and since their origin can be traced to the cylindrical epithelium of the glands the first assumption is that it is a metaplastic change. If that is so it is very remarkable that there should not have been a further differentiation of the cells. As stated before these collections of cells simulate those found under cylindrical epithelium in the process of epidermidization. Here the cells differentiate into a tissue that at first is similar to that of the transitional epithelium of the bladder and then becomes normal squamous epithelium but this only takes place after the cylindrical epithelium has been cast off (Fluhmann 8). In our case the masses of cells were all deep in the glands and one wonders if there would have been mature squamous epithelium had they occurred at a point on the surface. However such an explanation is problematical since metaplastic changes in other benign conditions and in adenocarcinoma show fully developed squamous epithelium deep in the glands.

There has been no satisfactory explanation offered to account for the etiology of this lesion. A study of the 6 cases that have been reported shows that the only factor common to all is that the change occurred in glands of hyperplastic endometrium and it is noteworthy that similar findings have not been reported in any other benign condition. It is also of some interest that all the patients were nulliparae (with the exception that this information is not given in Meyer's case). There were likewise no special features in the clinical history as the symptoms complained of are those usually associated with hyperplasia of the endometrium and consisted mainly of irregular bleeding. The age incidence was variable as 2 of the patients were 43 years old and the others 42, 34, 23 and 22 years of age respectively.

The third group of patients presenting squamous epithelium in the endometrium is thus limited to 6 reported instances. Of these cases 3 have been considered as carcinomatous and, as benign lesions. The main characteristic is that there are well

defined collections of small polygonal cells with round nuclei associated with hyperplasia of the endometrium. The chief complaint has been irregular and profuse uterine bleeding. No satisfactory explanation for the occurrence of the abnormal cells has been forthcoming but it is assumed that there is some form of metaplastic change from cylindrical to squamous epithelium. Further study and the investigation of additional cases is necessary before an exact interpretation of this lesion can be reached.

SUMMARY

The occurrence of stratified squamous epithelium in the endometrium has been described in a number of benign conditions in adults and young children and it has also been produced experimentally.

The finding in malignancy may be grouped into 4 categories: (1) squamous epithelium occurring as a metaplastic process in an adenomatous carcinoma of the uterine cavity; (2) squamous cell carcinoma coexisting with an adenocarcinoma; (3) squamous cell carcinoma of the corpus secondary to a similar growth of the cervix uteri; and (4) primary squamous cell carcinoma of the uterine body.

Six cases have been reported of unusual epithelial masses occurring among glands in hyperplastic endometrium. The lesion is considered to be due to a metaplastic change from cylindrical to squamous epithelium. The exact significance of this change can not be determined but there is not sufficient evidence to consider it as definitely malignant.

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3 G E B H C Z t c l r f G b u t h u Gyna k 83
4 G E S N I A Z t c l r f G l t h Gyna k 89
5 H E N G A M t h f G b r t h u Gyna k 9
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8 H I T C I L A I f Gyna k 9 3 1 6 9
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7 M E J A r h f Gyna k 9 2 304
8 I d m Z t c h f G l u t l Gyna k 1898
9 N A o K M t c h f G b t h u Gyna k
3 N I C C A m J O l t 9 7 1 787
3 P E A N L N T I L L J / n t l b l f Gyna k 893
3 P I N O Z t l f H k 887 334
33 P N O Z t c l f G b t h Gyna k 19
34 R I A m C y & O b t J 896 84
35 S F T F v W Gyna k R I h 9 93
36 S H U T I Z t h f H k 887 3 3
37 S I M T T W Z t c h f c b t l u Cyna k 9 4
1 373
38 S c r R K I u l D t t H l b
39 S I T L N D E R J W k l W h h 9
933
4 I T R F Y A Cyna k R u d h 19
4 I d m Z t l r f G b t h u Cyna k 90 1
38
4 S A G L W A r h f Gyna k 89
43 I T J Z t c h f G b t h Gyna k 83
44 W R R A c h f Gyna k 895 1 360
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46 W L S J R a d D u B R O A m J D C h M
9 3 43
4 W o H S B a d H o f P I J F x p M d
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48 Z E L R A Z t h r f G l t h u Gyna k 83
56
49 Z R E I R A h f Gyna k 9 3 3
5 I d m Z t l l f Gyna k 9 1 33

CHOLEDOCHUS CYST¹BY I. STARR JUDD, M.D., F.A.C.S., ROCHESTER, MINN., AND
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J. H. S. S. Th. M. Y. T. d. t.

FROM July 1, 1907, to January 1, 1906, 17381 operations were performed on the biliary tract at the Mayo Clinic, yet true cyst of the common duct was encountered only once. One other cyst of the common duct was found but it was not idiopathic and was present in a case in which cholecystectomy had been performed and stones found in the common duct.

Because of the extreme rarity of the condition it is seldom diagnosed. According to the literature the diagnosis has been made preoperatively in only one case that reported by Neugebauer in 1924. In one other case that reported by Wright, choledochus cyst was thought of in the diagnosis but was dismissed because of the presence of round worms, and a diagnosis was made of possible occlusion of the cystic and common ducts.

According to Lvenson, the first case of cyst of the common duct was that cited by Vater in 1723. Fodd in 1817 reported another case. In these two cases, however, there is some question as to the pathogenesis of the cyst because of the presence of scirrhous pancreatitis causing obstruction. Since the condition is so rare, especially in children, and since the patients in the two cases were young, they probably should be included. In our series we have not considered any case in which a possible cause for the dilatation might be entertained.

REPORT OF CASE

A girl, 13 years of age, entered the Mayo Clinic on January 6, 1907, complaining of attacks of liver trouble. Since infancy attacks of vomiting had occurred with pain in the abdomen mostly under the right costal margin and in the mid epigastrium. In 1902 the appendix was removed after an attack. Five months later a similar attack occurred. Since then there had been from two to four attacks yearly. As the patient grew older the attacks became more frequent and severe and morphine was required for relief. The excruciating pain in the right costal margin passed through into the back and right

shoulder. Residual soreness was characteristic. Jaundice had been present 5 years previously and again 1 year before admission. The stools were clay colored from the last attack. Thanksgiving day, 1906.

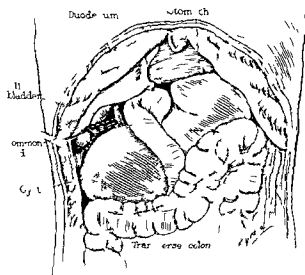
Examination for the most part was negative except for the presence of a movable mass in the epigastrium. There was also slight tenderness at the right costal margin. Examination of the blood and urine was negative. There was no free acid in the stomach. The gall bladder was not visible in a Graham-Cole roentgenogram. The coagulation time was 6 minutes; the calcium coagulation time was approximately 5½ minutes; the blood calcium, 9.6 milligrams; and the direct van den Bergh serum bilirubin, 6.4 milligrams for each 100 cubic centimeters. A diagnosis was made of cholecystic disease, probably with stones, and operation was advised.

Exploration revealed a congested gall bladder and a cyst of the common duct about 12 centimeters in diameter (fig. 1). The bile in the gall bladder and in the cyst appeared normal. After a small opening had been made in the cyst for the escape of bile it was anastomosed to the side of the duodenum with silk and chromic sutures. A tube was placed in the gall bladder.

The postoperative period was uneventful and the child left the hospital on the nineteenth day in splendid condition. From the tube within the gall bladder 60 cubic centimeters of bile drained the first day, 20 cubic centimeters the second day, and 5 cubic centimeters on the third and fourth days. No bile escaped after the fourth day and on the fourteenth day the tube was removed. The wound healed promptly, the jaundice disappeared, and the patient left for home February 8, 1907. A letter written August 1, 1927, stated that she was perfectly well.

This type of enlargement differs markedly from that which is so commonly found as a result of stones in the common duct or in disease of the pancreas. In the latter the common duct enlarges as a whole but retains its normal form and never is much larger than a loop of small intestine in the former; however, the middle and upper portions of the duct are dilated, enlarging slowly and progressively, not unlike a sacular aneurysm.

The cysts vary from 2.5 by 3 centimeters in diameter, as reported by Hüliger, to those



1 Cyst of the common duct

which fill the entire abdomen and are most commonly described as being the size of a man's head. The terminal or intramural portion of the common duct is as a rule not involved although Fowler in his case was able to insert the examining finger through the terminal portion of the duct into the duodenum. The position of the cyst varies with its size. The moderate sized cyst usually lies below the liver but may extend in any direction down to the pelvis. The duodenum is forced to one side, the stomach is pushed to the left and is often turned on itself. The ascending and transverse colon are of necessity pushed to the left and downward.

ETIOLOGY

The condition is generally considered to be congenital. In support of this theory is Heiliger's case noted in a stillborn fetus almost at term. The cyst in the common duct measured 2.5 by 3 centimeters. Heiliger concluded that the weakness was primarily in the wall of the duct.

Rostowzew believes that the cyst is a result of an abnormal course of the choledochus through the wall of the duodenum. On several occasions it has been found that the end of the duct instead of entering the duodenum from right to left opens from the front backward

in other words from left to right producing a kink and any obstruction to the flow of bile dilate the choledochus (Fig 2). Lavenson is not in accord with this explanation and feels that the angular insertion instead of being the cause of the dilatation is a result. He shows that a choledochus lying in the gastrohepatic omentum lies further to the right and that the hepatic artery and the portal vein will prevent dilatation to the left. Since no structures are interposed to the right of the duct it takes the course of least resistance and as a result changes the direction of the duct. He believes however that the underlying cause for the dilatation is a congenital weakness in the wall of the choledochus and following even temporary obstruction such as a mucous plug or catarrhal cholangitis there is sufficient resistance to the outflow of bile to result in cystic formation and later in angular insertion of the lower portion of the duct.

In Budd's case the ampulla of Vater was on the right and anterior aspect of the second portion of the duodenum instead of on the posterior and internal portion. Thus he claims is indicative of abnormality in the rotation of the midgut and the peritoneal fixation of the duodenum all of which might influence dilatation of the choledochus. He believes however that the cysts are due to congenital dilatation of the extrahepatic portion of the common duct increased by valvular obstruction at the lower end by inspissation of bile. He suggests that the primary diverticulum is the result of a pancreatic rest in the wall of the common duct the cells of which break down and a dilatation of the duct follows. He bases this hypothesis on the analogy of diverticulum of the duodenum which often contains pancreatic tissue.

According to Waller the cystic dilatation is the result of a valviform duplication of the wall (Fig 3). Because the cyst enlarges to the right and downward there is pressure on the fixed portion of the common duct thus preventing the outflow of bile from the cyst. This valve-like duplication has been observed clinically by a number of investigators and explains the intermittent jaundice. This phenomenon entails the emptying of the sac with the cessation of the jaundice and

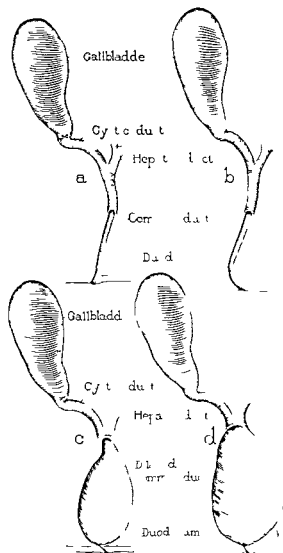


Fig 2 a The normal course of the common bil duct through the duodenal wall b c d the int amural portion of the duct running from left to right producin an angle resulting in obstruction to the outflow of bile and formation of cyst

reappearance of the phenomenon with closure of the sac. The emptying and closing of the sac is accounted for as follows. When the sac reaches a certain degree of fullness the left wall presses on the fixed wall of the choledochus so that emptying is impossible. The constant flow of bile from the liver expands the sac further and finally the kink which has been obstructing the duct is freed and the bile is permitted to flow temporarily through the choledochus into the duodenum. Clinically this phenomenon has been reported by Ros towzew Heid and Wettwer who noticed that increase in the size and tension of the sac was followed by reduction of both

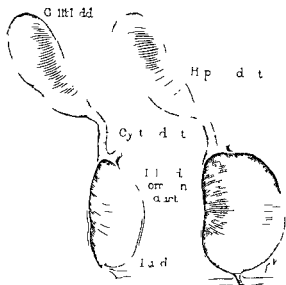


Fig 3 Valviform duplication of the wall of the cyst with closure of duct. C pan ion of the sac and frein of kink

Numerous other hypotheses have been advanced as to the cause of the cyst. Certain investigators believe that the muscular tissue of the duct is weak. Others believe that there

TABLE I—TYPE OF OPERATION ON PATIENTS WHO HAVE RECOVERED

Surgeon	Year	Operation
Sw in	894	A piration followed by choledochoduodenostomy
B un and Hartmann	1897	Extirpation of sac by Brun choledochoduodenostomy by Hartmann
Bak	1906	Primary choledochoduodenostomy
Sternberg	1911	Cholecystectomy and choledochoduodenostomy
Hildebrand	1913	Drainage later choledochoduodenostomy third operation to make a larger stoma
Rotgans	1913	Drainage and cholecystectomy 4 months later choledochoduodenostomy
Wall r Kemer	1916	Primary choledochoduodenostomy
Boll	1920	Drainage later choledochoduodenostomy
Krabbel	1922	Drainage later choledochoduodenostomy
McWhorter	1922	Extirpation of sac cholecystectomy and hepatic duodenostomy
Adam	1923	Drainage later choledochoduodenostomy
B l man on	1923	Drainage later choledochoduodenostomy
Morl y	1923	Drainage later choledochoduodenostomy
Zimmer	1924	Drainage later choledochoduodenostomy
P mperl J dd	1925	Cholecystectomy and choledochoduodenostomy
	1927	Cholecystectomy and choledochoduodenostomy

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE II—SUMMARY OF CASES

A th	Y	S	A y	E	u	P	pe	d	gn	T	tm	t	E	d	hs
D gl	1895	F	17	+	+	?				A			f	d	d
K ky	1898	F	21	+	+	E h				E	f		D	d	d
S yd t	1898	F	23	+	+	I				D	g		D	d	d
A	1901	?	?	+	+	P				D			D	d	d
H d	1893	F	14	+	+	G	l	t	b	I	s		D	d	d
Sw	1894	F	17	+	+	Hyd	d			M	d	l	D	d	d
Ldg w h	1895	F	4	+	+	E	l	g	d	h	b	l	h	d	d
I	1896	F	33	+	+	S				D			R	e	c
B	1897	F	10	?	?	E	h			C	y	p	I	d	d
H d	1897	F	3	+	+	E	h			f	l	b	D	d	d
R w w	1897	F	13	+	+	E	h			m	f	l	I	d	d
R l	1877	M	8	+	+	E	h			h	m	f	R	y	
A hby	1898	F		+	+	I	t			C	y	l	I	d	d
N l	1898	F		+	+	I	d			D			D	d	d
I m	1904	F	24	+	+	E	l			D			I	d	d
G y H p m	1904	F	21	+	+					D			D	d	d
H l g	1905	M	S	?	?					T	a	s	D	e	d
K lb	1905	F	10	+	+	E	h			I			C	y	
R lles	1905	F	15	+	+					?			I	t	
A ld	1906	F	13	+	+	E	h			?			C	f	
Bak	1906	F		+	+	P				I			D	d	
G ld mm	1907	F	21	+	+	E	h			L			I	f	
Pb	1909	F	18	+	+	L	e			D			D	f	
La	1909	F	8	+	+	E	h			I			D	d	
B	1910	M	5	+	+	I	d			I			D	d	
W	1910	M	6	+	+	E	h			D			D	d	
Cl m	1911	M	2	+	+	I	t			D			D	d	
S hl m	1911	F	7	+	+	L	h			D			D	d	
St b	1911	F	25	?	?	I	t			D			D	d	
E	1912	F	23	+	+					C	h		D	d	
M m	1912	M	2	+	+	R				I			D	d	
H l b d	1913	F	18	+	+	C	y			C	h		R	e	
I r	1913	F	18	?	?	I	t			D			D	d	
L l	1913	F	25	+	+	I	t			M			D	d	
R	1913	F	5	+	+	C	h			D			R	e	
S h lb	1913	F	5	+	+					M			I	d	
S l g	1913	F	5	+	+	L	e			D			D	d	

F m M Wh t b l t
 † R p o e d by M y h

TABLE II—(Continued)

A th	Y	Ag	E	P	P p t d g	T t m t	F d l t
R b t	1914	1	+	+	?	D g	D d l k l t
Sm t	1915	F	17	+	L h fl y t y t	E t p t f y t	D d d y l t
F w l	1916	M	2	—	A l l h l y t d	Ch l y t t m y l h l d	D d l d y l t f m th
W l l	1916	I	10	+	N	Ch l e l h d t t m y	R y
W g	1918	I	47	+	M l t t m th	Ch l l o c h l l t m y w h	D d d y l t f m p e d g
M C l l	1910	I	11	+	D g fl	M r h y b t t	D h l t
K m	1910	I	18	+	(y t f l)	D g t w p l t t	A l 3 y l t
S h b l	1911	I	3	+	E h o c c y t	D g m t m b t	R y
B l l	1922	I	13	+	L p t t d h	A p t 3 m th l t	D d d y l t f m p e d g
B d d	19	M	2	+	Ch p t t	I d m b t	D d d y l t
K b b l	1922	?	8	+	L l t h	D g m t m b t	R y
R l d B l l	1922	F	56	+	N	A p t 3 m th l t	D d d y l t
Y m h	1922	F	4	+	?	I d m b t	R y
Y m h	1922	I	16	+	?	I d m b t	R y
Ad m	1923	I	31	+	I d m t	I d m b t	R y
A b b y d P l t t	1923	I	65	+	N	I d m b t	R y
B h m	1923	M	35	+	R t t l m	I d m b t	R y
M W h t	1923	I	49	+	O b t t f m m	I d m b t	R y
M l y	1923	I	17	+	C y t f y	I d m b t	R y
W g h t	1923	M	15	+	B l k g f y	I d m b t	R y
Z p l	1923	I	12	+	T m h t p p q d	I d m b t	R y
N g b	1924	F	21	+	Ch l d h y t	I d m b t	R y
Z m m	1924	F	22	+	P l t y t y t l	I d m b t	R y
I m p l	1925	M	23	+	N	I d m b t	R y
R m y	1925	I	2	+	C y t y	I d m b t	R y
W y l l	1925	I	6	+	N	I d m b t	R y
J d l d G	1927	F	13	+	Ch l y t t w h t	I d m b t	R y

F m m W b t t b l t
 R p t d b y M l y

is congenital narrowing of the common duct as it pierces the duodenum and that as a result dilatation above occurs

Fenger believes that adhesions or an elongated duct cause bending of the choledochus. Syphilis has also been ascribed as the cause of the obstruction. Rolleston reports the case in a child 9 years of age with marked evidence of hereditary syphilis particularly of the liver and pericellular cirrhosis.

Examination of the sac reveals nothing definite. Epithelial lining has often been found on

microscopic examination and elastic fibers muscle fibers and a few glands have been found within the wall.

SEX AND AGE

Of the 64 case on record 52 of the patients were females 10 were males in 2 cases the sex was not given. The average age is 15½ years but it should be taken into consideration that most of the patients did not present themselves until after the symptoms had been present for from 2 months to 36 years. The

youngest subject was an almost full term male fetus noted by Heiliger the oldest was a woman aged 56 years observed by Reel and Burrell

ONSET

In most cases symptoms appeared before the patients reached the age of 10 many of them were not more than 6 months of age. The oldest patient was 20 years of age when the first symptoms were noticed

SYMPTOMS

In certain cases pain was the first symptom in others jaundice and in still others the presence of a tumor in the region of the liver was the first indication of disease. Undoubtedly a tumor is the most significant diagnostic factor. It may be barely palpable or it may fill the entire abdomen extending from the costal margin to the crest of the ilium. In some cases there is no tumor as was observed by Fenger Rotgans McWhorter and Fowler. In some cases two tumors were present (Dreesmann Mayesima Arnolds Seeliger and Russell) one being a cyst of the common duct the other a distended gall bladder. The cysts vary in size and consistency depending on emptying ability. It has been noted definitely that several hours after a meal the tumor becomes larger and firmer probably because of the active secretion of bile at this period.

Jaundice was the most constant symptom in all the cases reported. The degree varied in different cases from a slight icteric tint to severe icterus. As a rule the icterus was intermittent but in a number of cases it was continuous. In the Guy's Hospital case it lasted 2½ years. Jaundice was absent in the cases cited by Smit and Bolle. Acolic stools were the rule in most of the cases observed. Pain varied from simple flatulency of the abdomen to excruciating colic requiring morphine for relief. The pain occurred usually in the right upper quadrant often shooting into the back and up into the right shoulder. Eating often precipitated an attack. In a number of instances however pain was not present. Other symptoms of lesser importance were nausea vomiting and diarrhoea. Sometimes there was fever during an attack.

DIAGNOSIS

As has been stated the diagnosis of choledochus cyst has been made pre-operatively but once (Neugebauer). The most common diagnosis was echinococcus cyst (Swain Russell Konitzky Brun and Hartmann Rostowzew Dreesmann Kolb Arnolds Goldammer Ebner Lavenson Weiss Schloessmann Letulle Seeliger Smit Schuerholz Bolle Krabbel). A diagnosis was made of pancreatic cyst by Seyffert Arnison Bakes Ebner Zimmer of stones in common duct by Fenger and McWhorter of hydrops of the gall bladder by Edgeworth Schloessmann and Lavenson of mesenteric cyst by Bake and Zimmer of malignant tumor by Arnolds and Warner of retroperitoneal cyst by Mayesima and Bohmansson of cyst of the liver by Hildebrandt Smit Kremer Bolle Krabbel and Zimmer of generalized tuberculosis² by Broca of chronic peritonitis by Budde of tumor in the right upper quadrant by Zipf of cyst of the ovary by Morley of obstruction of the common and cystic ducts from round worms or possibly cyst of the common duct by Wright of cholecystitis by Rotgans and Fowler of hydro-nephrosis by Ramsay and Hill and Zimmer of perforated gall bladder by Seeliger and cholecystitis and stone by us. The diagnosis was indeterminate in the case reported by Ashby Nicolayson Butters Clairmont Sternberg Ipsen Roberts Waller Reel and Burrell Morley Adam Wylie and Pamperl.

The diagnosis should be made more frequently. Especial diagnostic factors are recurrent attacks of jaundice with pain in the region of the liver and the presence of a palpable cystic tumor in the right upper quadrant appearing in a young individual especially a young female.

TREATMENT

Any type of operation should be carried out that will permit the bile from the cyst to enter the upper gastro intestinal tract. One reason for the high death rate is that the condition has been unknown to the surgeon at the operating table. The presence of jaundice at the time of operation is another cause for the high mortality rate.

Hildebrandt and Seeliger reported the first case of choledochus cyst which was found at autopsy.

In nearly every case in which drainage to the surface was the only operative procedure death resulted. An attempt was made to anastomose the cyst with the duodenum after drainage had been instituted at the first operation by Ashby, Dreesmann, Rotgans, Hildebrand, Seeliger, Schuerholz, Kremer, Brun, and Hartmann, Bolle, Krabbel, Morley, Adam, Bohmansson, and Zimmer. It is of interest to note that Ashby aspirated in his case 10 times before he finally attempted an anastomosis but unfortunately the patient died the day after the operation. Eight of these patients recovered after a second operation had been performed, namely those of Rotgans, Morley, Bolle, Krabbel, Bohmansson, Zimmer, Brun, and Hartmann, and Hildebrand.

External drainage alone was fatal in all but 2 cases. McConnell first instituted drainage by inserting a tube into the cyst. Eight months later the patient reappeared with pain in the abdomen and swelling in the upper quadrant. The abdomen was again opened and the cyst washed. The patient remained apparently well for 2 years before symptoms reappeared again; the abdomen was opened and the cyst explored. Seven months later the patient apparently was in normal health. Reel and Burrell inserted a tube into the cyst. Three weeks later an abscess formed which required drainage. A fistulous tract persisted for 9 months; the patient was in good condition 18 months after operation.

Marsupialization of the sac has been performed a number of times with fatal results (Letulle, Goldammer, Smit, Lavenson).

Anastomosis between the cyst and the upper part of the bowel was first accomplished by Swain in 1894 when he performed choledochojejunostomy using a Murphy button.

The first successful primary choledochoduodenostomy was performed by Bakes in 1906. Since then this operation has been performed by Sternberg, Wagner, Waller, Neugebauer, Wylie, Pamperl, and Judd. Three patients died; those of Wagner, Neugebauer, and Wylie.

Yamanouchi and others have advised drainage first and later some sort of anastomosis to the bowel. McWhorter on the other hand advises hepaticoduodenostomy with partial

or complete excision of the sac whenever possible in order to reduce stasis of bile with intestinal contents and thus lessen the tendency to cholangitis.

The principal cause of death was hemorrhage; other causes were peritonitis, exhaustion, cardiac failure, cholangitis, and shock (Tables I and II).

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THE RESULTS IN ONE HUNDRED CONSECUTIVE CASES OF HYPERTHYROIDISM OPERATED UPON

A CLINICAL AND HISTOLOGICAL STUDY ATTEMPTING TO CORRELATE THE MORPHOLOGY AND CLINICAL PICTURE WITH A VIEW TO PROGNOSIS

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F mth L h y Cl dth P th l l Labo t fth N F gl l D H d M d l s h l H pt l N E gl nd B pt t H pt l dth

THIS paper is based on a clinical and histological study of 100 cases of hyperthyroidism operated upon in the Liley Clinic and followed for a year or more by clinical and metabolic examination at intervals of 2 to 4 months after operation. The cases were selected by taking the last hundred cases operated during 1925 starting in December and working backward. No case in the records was omitted until 100 were obtained.

Our object in this study was first to learn our end results after thyroidectomy in primary hyperthyroidism since the adoption of iodine administration before and after operation in the care of these patients. Second we wished to learn if our clinical impression that low basal rates and myxedema were more frequent since the use of Lugol's solution was correct. The importance of this problem to the surgeon in his decision as to the amount of thyroid tissue to be left at operation is very great. Third we wished to know whether or not postoperative myxedema was related to the degree of lymphoid infiltration (strumitis) present in the thyroid gland. Finally we wished to discover whether one could prophesy the possibility of myxedema (or persistence of toxicity) from the histology of the thyroid gland as evidenced by the degree of involution, the amount of lymphoid infiltration and the presence of acidophilic cells in the sections (fig. 6).

Relief from the symptoms of hyperthyroidism was complete and satisfactory in 9 per cent of this group of patients. There was one patient whose clinical improvement was marked and whose basal rate was $+17$ when last seen 3 months after operation and who later committed suicide. We have not included her in the above group of 9 patients. The 7 remaining patients still showed evi-

dence of persisting hyperthyroidism and we cannot class them as cured. All of these 7 however were much improved and were taking Lugol's solution and all were doing a large part of their usual daily work. The average basal rate for these 7 patients 10 to 14 months after operation was $+6.4$. The highest of the group was $+40$ and the lowest $+11$. Only 2 of this group seem to us to have sufficient hyperthyroidism uncontrolled by Lugol's solution to warrant further removal of thyroid tissue. All of this group of 7 were very toxic on admission to the Clinic and 5 required a two stage thyroidectomy. It can be said definitely that all 7 are much improved over their previous condition even though they are still somewhat toxic.

From our study of these 100 cases we can find no reason to alter our belief that the proper removal of sufficient thyroid tissue will cure the patients of the symptoms of hyperthyroidism.

In these 100 cases of subtotal thyroidectomy the operation was done in one stage in 67 cases, in two stages in 32 cases, and in three stages in one case. There was no mortality in this group of patients.

Figure 1 shows the change in basal metabolic rate in this group. The solid line shows the average rate for the entire group before and after operation. The broken lines show the changes in the rate in the patients done in one operation and in 2 or more operations respectively. These curves show the typical drop in basal metabolism which occurs with the use of Lugol's solution and rest in bed before operation. It is evident also that of those patients who in our judgment at the time of operation could not safely have had a subtotal thyroidectomy in one stage, all had a higher basal rate both before and after the

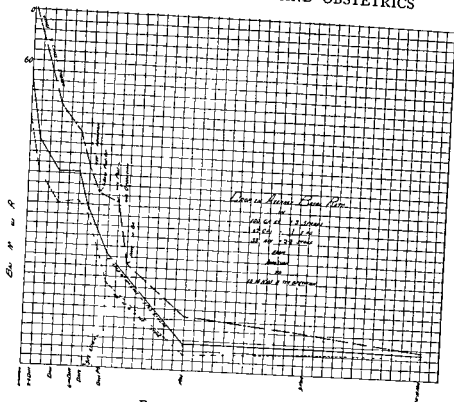


Fig. 1. Dependence of the rate of

use of Lugol's solution than the cases done in one stage. Whether the operation was performed in one stage or in multiple stages however the basal rate reached approximately the same level a year after operation and examination of these patients shows that the clinical improvement in the two groups is equally marked and satisfactory. Although a one stage thyroidectomy when safe is greatly to be desired from the economic point of view it is important to recognize that an increase in the number of operations will increase the factor of safety and still produce the same final result.

Of the patients in this series 19 per cent showed a basal metabolic rate 10 to 14 months after operation which was lower than -10. Of these 4 patients had rates of -11 -12 -13 and -15. They had no symptoms that we could detect clinically which were referable to a lowered basal rate. They felt well, worked and played regularly and we classed them as well.

There were 15 patients however who had basal rates below -10 who showed definite evidence of myxedema and who were taking

either thyroid extract or thyroxin. The lowest rate in this group was -35 the highest $+11$ and the average rate was -28 before treatment was undertaken.

The incidence of postoperative myxoedema in 15 per cent of these patients is high and we believe that it is much higher than in our previous experience. There are two factors which to some degree account for this increase in myxoedema. In 1924 we made a study of our patients showing persistence or recurrence of hyperthyroidism after thyroidectomy and became convinced that we should remove more thyroid tissue than had previously been our custom. In doing this we undoubtedly removed too much tissue in some instances. The decision as to the proper amount of thyroid tissue to be removed or what is more pertinent the amount of thyroid tissue that shall be left behind is a most important one. It is probably preferable to have a slightly lowered basal rate after operation than one that is persistently elevated. Patients with myxoedema do very well with thyroid extract or thyroxin medication although we do not feel that they are entirely

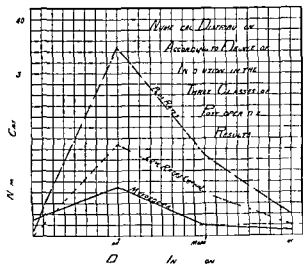


Fig. 2 Numerical distribution according to the degree of involution in the three classes of postoperative results

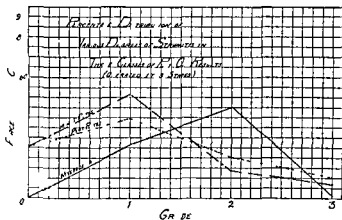


Fig. 3 Percentage distribution of various degrees of strumitis in three classes of postoperative results

normal Weakness and increased fatigability are common difficulties with them often replaced by palpitation and nervousness as the dosage of thyroid extract is increased. In spite of this fact however we feel very strongly that this condition is far more desirable than hyperthyroidism if one could choose between these conditions. The second factor in this high incidence of myxœdema is the involution produced in the hyperplastic thyroid gland by Lugol's solution with which we had had relatively little experience in 1925 and prior to that date.

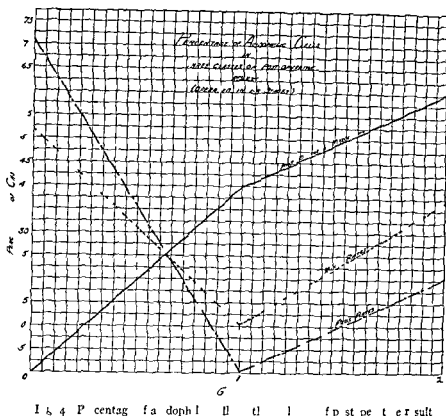
The histology of the hyperplastic thyroid gland shows remarkable changes after the use of iodine. Iodine produces involutionary changes regressive in character. Much of the activity of the gland is reduced and we should bear this in mind when removing this type of gland. It apparently requires more of the involuted thyroid gland to maintain a normal basal rate than it does of the actively hyperplastic gland. Failure to realize this in this series probably accounts for some of the cases of myxœdema following operation.

The presence or absence of strumitis in patients with primary hyperthyroidism we felt might be a factor in the etiology of postoperative myxœdema. It was the impression that myxœdema would not occur after subtotal thyroidectomy in primary hyperthyroidism untreated with iodine and without strumitis and that myxœdema might and did occur if thyroidectomy were performed in

cases with marked thyroiditis. The distinction between inflammatory cellular infiltration and lymphoid hyperplasia in this respect is extremely confusing.

We feel that this distinction is one which should be made as far as possible but is one which offers unusual difficulties. It is perhaps almost trite to say that fibrosis is an inevitable sequence of lymphoid infiltration of tissues generally presumably is part of a defense mechanism in an effort to wall off an injured area. This obviously interferes to some extent with our interpretation of lymphoid infiltration and fibrous scarring as opposed to simple lymphatism and fibrosis. The chief differential point accordingly is the focal distribution of the lymphoid cells in simple lymphatism is contrasted to the rather more diffuse infiltration of the lymphatic and scar tissue in true inflammatory lesions. Accompanying this is a fairly marked pressure atrophy of the acini in the involved areas in the inflammatory process whereas in the simple lymphoid hyperplasia essentially no interference with acinar function is to be noted.

Of the 15 cases of myxœdema there were 8 who showed a basal metabolic rate of +30 or less on admission. Six of these 8 patients had been given iodine for varying periods of time before coming to the Clinic. The diagnosis of hyperthyroidism in these cases was made on the history of increased appetite, loss of weight, eye signs, tachycardia, goiter, tremor, nervousness, etc. Repeated metabolism tests were performed which were



persistently elevated above a normal level although they remained below + 10. The diagnosis of hyperthyroidism in this group of patients who have received iodine before examination must be carefully reviewed in each case and is often difficult. The true severity of the hyperthyroidism may be so masked as the result of iodine therapy that a fatality or serious reaction unexpectedly follows operation or the diagnosis of hyperthyroidism may be wrongly made because of the belief that the relatively low basal rate is simply the temporary result of iodine medication. In any patient whose basal rate is not definitely and persistently elevated we regard the diagnosis of hyperthyroidism with great suspicion. Many of these patients we now send home for 4 or 6 weeks with orders to discontinue iodine or other medication and to return for further study at the end of that period. We are extremely hesitant to operate on a patient whose basal rate is normal. If however operation is performed in some unusual case in which our clinical findings show very strongly the presence of hyperthyroid

ism in spite of a basal rate but slightly elevated we leave a much larger segment of thyroid tissue behind than has hitherto been our custom.

The 7 other patients in this group had very high basal rates on admission to the hospital but developed myxedema postoperatively. This resulted we believe because of the removal of too much thyroid and the postoperative use of Lugol's solution which reduced the activity of the remaining thyroid tissue.

With the clinical results in mind an attempt has been made in this series of 100 cases of hyperthyroidism operated upon to correlate the histological findings with the clinical picture. Certain of the more outstanding histological features have been tabulated on a gradient scale based on 0 to 3. Of these it was felt that 3 might be of more probable value prognostically than any other.

For some time we have been trying to correlate the degree of involution of a gland with the clinical findings measured chiefly by the metabolic rate. Here the figures 0, 1, 2 and 3 have been employed to indicate no change

early moderate and advanced involution respectively. The criteria vary slightly with the personal equation but we have found in our examination of over 2000 such glands during the past few years a surprising uniformity of classification results so that it is only the occasional gland on which we do not independently agree. The important points in this instance are (1) the variation from the high columnar epithelium to the normal low cuboidal cells (2) the size of the follicles and (3) the amount and staining characteristics of the intra acinar colloid. Other less significant features are the amount of papillary infolding of the lining epithelium of the acini and the presence of the so called inter acinar cells of Weber which we do not feel have yet been conclusively demonstrated as existent. We have always considered that these cells merely represent tangential sections of acinar epithelium and the examination of countless serial sections seems to support this hypothesis.

This involution has been plotted numerically in Figure 5 on the basis of the clinical picture and metabolic rate. In other words the degree of involution at the time of operation and then the metabolic rate at the end of the period of observation have been recorded on the basis of cases showing a plus or minus rate with the cases showing definite clinical myxedema plotted separately. There is no deduction of significance in prognosis to be drawn from a study of this feature. If one translates these figures into percentages in

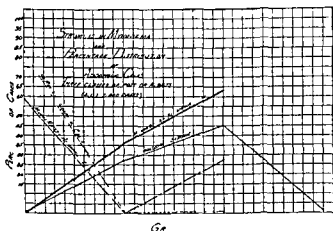


Fig 5 Strumitis in myxedema and percentage distribution of acidophilic cells. Three classes of postoperative results.

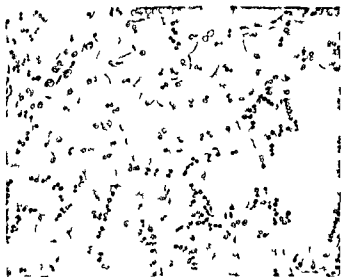


Fig 6 Camera lucida drawing illustrating the acidophilic cells described in the text. Primary hyperthyroidism with acidophilic pseudo adenomatous hyperplasia. Ref No D 27565 X360

each group the curves are practically superimposed. The second feature is based on the amount of inter acinar lymphoid infiltration. Whether or not this represents a true inflammatory repair process or is merely one manifestation of generalized lymphatism is of no importance at the moment. Morphologists have disputed this point for years and no agreement is as yet in sight. Certain it is that in many cases the lymphoid infiltration is sufficient apparently to interfere seriously with acinar function and for this reason it might legitimately be considered as a possible factor in producing hypothyroidism. As in the case of the involution the degree of lymphoid infiltration has been recorded on a 0 to 3 graded scale with 0 meaning no lymphoid infiltration, 1 occasional focal aggregations of lymphocytes sometimes forming follicles—rarely more than one such group to every 3 or 4 low power fields, 2 frank scattered follicle formation seen in nearly every other low power field, 3 diffuse lymphocytic infiltration with follicle formation obscuring every field. In addition Riedel's type of strumitis essentially a lymphoid replacement of the acini might be termed 4+ on this scale. No specimens happen to be included in this series however.

In the same way as in the case of the degrees of involution the degree of strumitis at

the time of operation has been plotted in Figure 3 against the clinical picture as measured by the basal metabolism rate at the end of the observation period. In this instance the percentage in each group is utilized as it tends to bring out more sharply the fact that incidence of marked lymphoid infiltration is more prominent in the myxedema group.

The third feature is one about which we have not found any comment. We have been seeing atypical cells usually in small groups often involving several acini which become somewhat separated from the remainder by delicate connective tissue septa. The chief characteristics of these cells are a marked increase in size of both nucleus and cytoplasm and typically a rather intense acidophilic staining reaction of the cytoplasm. Usually they line small acini with hardly demonstrable lumina containing little or no colloid. We have been inclined to call them acidophilic pseudo adenomata and have speculated as to their meaning. Did they play a part in the development of simple adenomata? Were they the precursors of malignancy representing anaplasia? Were they an exhaustion form of the cell? Were they hyperplastic cells compensating for general glandular exhaustion?

These cells accordingly also were tabulated on a 0-1 gradient scale without any reference to the clinical history primarily to see if they seemed to be related to any of the other histological variations as well as in respect to the basal metabolism rate and clinical picture.

As a result of this study certain points seem to have been brought out which may be of some value clinically. The degree of involution is of very little practical importance either in estimating degree of toxicity as measured by the basal metabolism rate at the time of operation or as a prognostic sign as to subsequent myxedema. Many factors enter into the explanation of this discrepancy chief of them being the difficulty of estimating the amount of iodine administered. Before the routine pre-operative administration of iodine the correlation between the histology and the basal metabolism rate was much closer. Today however the basal metabolism rate usually lags behind the morphological

change but with no given regularity so that marked variations may exist compatibly.

In respect to the degree of lymphoid infiltration there is also very little correlation and we are inclined to suspect that the lymphoid infiltration which is so frequently interpreted as being inflammatory in character may be merely a manifestation of general lymphatism possibly part of the picture of disordered metabolism in which the balance of other ductless glands may be disturbed as we see experimentally in thymic and adrenal dysfunction. At all events there seems to be no essential common relationship between the degree of lymphoid infiltration of a hyperplastic gland (strumitis) and the degree of involution and very little relationship between the degree of strumitis and the subsequent development of myxedema save in the extreme cases in which the differential diagnosis from Riedel's struma or malignancy may be most difficult.

In respect to the third feature—the presence of acidophilic cells—we feel that we have noted an occurrence of more than passing interest and one that may prove to be of some clinical value. Generalizing it may be said with a fair degree of accuracy that in none of the 15 cases which developed myxedema were these cells absent and in most instances they were to be found in relatively large numbers. This is illustrated in Figures 4 and 5 in which again the percentage incidence is plotted.

Similarly on the other hand it may be said that out of a total of 36 cases in which a one stage hemithyroidectomy was done in which the metabolism remained +10 or higher after a year only 4 definitely showed the presence of these cells while they were suspected in 2 other cases. In 7 similar cases in which there was no clinical evidence of myxedema at the end of a year except a minus basal metabolism rate 10 cases definitely showed this type of cell while 4 others were thought to contain cells which might be termed transitional toward this form.

In a smaller group in which the operation was done in two stages the parallel is not so close. There are 20 cases in 10 of them no acidophilic cells were found at either opera-

tion and the basal metabolism rate is over $+3$ in the 10 remaining cases showed them definitely in both specimens and interestingly enough showed normal basal metabolism rate ± 0 and $+3$ respectively relatively low rates as compared to the series as a whole. Of the 8 other cases 5 showed the characteristic cells only in the first specimen and the 3 others only in the second specimen.

From such data we are perhaps not in a position to draw any very striking conclusions. It seems to us however that we have found these acidophilic cells too frequently to be merely coincidence in the cases which subsequently develop low metabolic rates with or without the clinical signs of myxœdema. In a review of these cases in relation to the clinical histories it seems safe to say that almost no case presenting these cells in the histological specimen has shown a persistent hyperthyroidism. Indeed it brings up as a speculative point whether or not the advisability of administering postoperative iodine may not ultimately rest on the pathological report as to the presence and number of these cells for such therapy has been used to prevent hyperplasia of the persistent gland tissue. In such cases perhaps it may be advisable to omit such iodine therapy in the hope of stimulating simple hypertrophy. Similarly may not the decision rest on the pathological report as to whether a second stage operation shall be performed in cases in which the initial specimen shows the undoubted presence of these cells because of the danger of subsequent myxœdema? And finally it is assuredly true that cases in which these cells occur with any degree of frequency should be more carefully watched for the development of myxœdema or lowered metabolic rates and therapeutic measures begun promptly.

SUMMARY AND CONCLUSIONS

A clinical and histological study of a series of 100 cases of hyperthyroidism operated upon in the Lahey Clinic and followed for a year or more by clinical and metabolic examination is presented.

Relief from symptoms of hyperthyroidism was complete in 92 per cent of the cases and

the remaining cases were all much improved confirming our belief that the proper removal of sufficient thyroid tissue will cure the patients of the symptoms of hyperthyroidism.

Nineteen of the patients had a basal metabolic rate at the end of a year of less than -10 . Fifteen of these showed clinical evidence of myxœdema. This incidence is higher than in the previous reported series and is probably the result of (1) the removal of larger amounts of the gland than formerly as the result of an undue incidence of persistent hyperthyroidism in the previous series and (2) the administration of iodine after operation to prevent hyperplasia.

Histologically in this series there is very little apparent correlation between the degree of involution and the basal metabolic rate or clinical picture although it is definitely felt that the pre operative administration of iodine is one of the chief factors in disturbing this relationship. Similarly there appears to be no relationship between the degree of involution and the incidence of either lymphoid infiltration or acidophilic cell formation.

In respect to the lymphoid infiltration there is no very close correlation as regards the metabolic rate in general although there is a somewhat suggestive parallel between the degree of strumitis and the incidence of myxœdema.

In regard to the presence of acidophilic cells in hyperplastic glands it may be concluded that there is some relationship between their occurrence and the development of postoperative myxœdema as they have been found in all the cases which subsequently developed myxœdema. It is not an absolute criterion however for occasional cases of persistent hyperthyroidism contained these cells in the original specimen and we have to estimate the amount of remaining gland before we can decide definitely their significance. We may conclude however that the presence of acidophilic cells is abnormal and is a danger signal not to be lightly disregarded. Their importance clinically with respect to subsequent operative procedures or medical treatment is still problematical but may well prove to be of some practical value.

CAUSES OF DEATH IN ACUTE INTESTINAL OBSTRUCTION

CLINICAL APPLICATIONS AND GENERAL PRINCIPLES OF TREATMENT

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HAUSLIE and Foster have recently emphasized the opinion that there are two distinct types of mechanical obstruction of the intestine: (1) acute simple obstruction in which there is occlusion of the intestinal lumen with no circulatory involvement in the distal part of the bowel wall and (2) acute translocation in which there is interference with the venous, arterial and lymphatic circulation as well as obstruction of the lumen of the bowel. Their publications in regard to this classification go far toward clarifying the confusion concerning the toxemia and the fatal mechanism of intestinal obstruction. After several months of experimental work during which time we were not acquainted with the work of Foster and Hauser we had independently arrived at a similar classification: (1) intestinal obstruction with uterine—simple obstruction and (2) intestinal obstruction with gangrene—translocation. In mechanism as well as in symptomatology the two conditions are entirely different and we feel that this classification enables us to explain most of the discrepancies which have occurred in the observations and conclusions of workers in this field.

CAUSES OF DEATH

Our investigation (1) have led us to the conclusion that in simple obstruction of the intestine without gangrene there is no absorption of toxin sufficient to cause death. Death is due to dehydration, loss of chlorides through vomiting and starvation. It is for these reasons that the experimental animal with a simple obstruction does not die of toxemia but may be kept alive through the period of starvation by the parenteral administration of sodium chloride solution. An animal however with any form of intestinal translocation is not saved by sodium chloride solution. In this case dehydration and hypochloremia are present perhaps to a marked degree but

death is due primarily to the absorption of toxins resulting from bacterial action in the distended and gangrenous bowel. Under such condition transfusion of sodium chloride solution constitutes a valuable therapeutic measure but cannot be expected to prolong life indefinitely.

HISTORICAL REVIEW

In the past 30 years much confusion has arisen from experimental work on the general subject of intestinal obstruction. Obviously the interaction of several factors in part metabolic and in part toxic offer conflicting possibilities and situation difficult to interpret until all the facts are understood. Toxemia has been the chief source of controversy. Following the work of Stone, Bernheim and Whipple (11) the view was held by many that the toxin is elaborated by a perverted secretion of the intestinal epithelium. This view apparently has been supported by the fact that experimentally closed loops of duodenum and jejunum rapidly prove fatal unless drained to the outside in which case the animal recovers. Sweet Peet and Hendrix (12) attributed the toxemia to the action of the pancreatic enzyme on the proteins present in the duodenum and showed that previous ligation of the pancreatic ducts prolongs life in the obstructed animal.

However none of these workers excluded the factor of bacterial activity. It is logical to suppose that the intestinal secretion may play a part in that they furnish the culture medium in which bacteria flourish. It is not likely that in themselves the enzymatic secretions are cause of toxemia.

Drigstedt, Moorhead and Burck (2) found closed loops of the jejunum in dogs to be fatal always within 3 or 4 days. If the isolated loop instead of being closed was washed and left opening into the peritoneal cavity the dogs which survive peritonitis remain well. In a

few weeks the loop is found to be sterile and may then be closed without causing toxic symptoms though the loop becomes distended and may even rupture. In these sterile loops the blood supply may be entirely occluded and anoxic necrosis develop. In the absence of bacteria this process causes no toxæmia.

In 1907 McClure (9) demonstrated that the stagnant contents of obstructed loops form an excellent culture medium which becomes loaded with bacteria. The bacterial content of the loop may be very slight at the time of closure but multiplication is extremely rapid. This rich bacterial growth not only provides the gas which damages the bowel by overdistention but also invades the strangulated tissue causing septic gangrene.

All workers are now admitting the importance of bacteria in producing the toxæmia of intestinal obstruction. Gerard (5) has stated that the contents of an obstructed bowel become poisonous as a result of the formation of histamine and allied proteolytic products by the action of putrefactive bacteria.

Murphy and Brooks (10) recognize the occurrence of a toxic substance within the bowel but emphasize the fact that absorption of the toxin does not occur through the normal intestinal epithelium. Haden and Orr (6) demonstrated this fact when they produced *simple* obstruction in dogs and kept them alive for 20 to 30 days by the hypodermic administration of sodium chloride solution. It is possible with such results to assume that sodium chloride has a specific detoxifying action but this view seems improbable.

Further emphasizing the importance of factors which control absorption Dragstedt, Dragstedt, McClintock, and Chase (1) demonstrated that a closed loop of intestine if previously washed with ether was not fatal to the animal. They found the loop contents however to be extremely toxic. Intraperitoneal injection of some of the contents into another dog caused death in 6 hours. The washing of a loop with simple astringents such as alum or tannic acid was found to be equally effective in preventing the symptoms of toxæmia. The role of these agents is not bactericidal; their action merely prevents absorption of

the toxin. McClure (9) had recognized these differences in 1907 when he concluded: "Thus if we exclude those conditions in which ulceration of the intestinal wall leads to perforation and peritonitis or in which infarction renders the wall permeable to bacteria it seems that obstruction of the intestine may persist for days with strangulation and enormous growths of bacteria in the obstructed loop."

The failure to keep these points in mind has caused many workers to draw conflicting conclusions from results in which proper explanation reveals no conflict. Discrepancies have arisen chiefly because numerous workers using different methods have emphasized different phases of the subject. The factors leading to the production of the toxin must not be confused with those which control its absorption.

DISCUSSION

In our experience with obstructed closed loops of the jejunum and ileum we have always found that death of the animal is preceded by gangrenous changes in the loop due apparently to overdistention resulting usually in perforation along the antimesenteric border. These changes occur much less readily in loops of the lower bowel than they do in the jejunum where the greater secretory activity causes rapid distention. It is for this reason that closed loops of the colon are not rapidly fatal. The loop contents are toxic at any level. The difference lies in the conditions which lead to gangrene of the bowel and absorption of the toxins.

We have found the filtrates from obstructed intestinal contents to be toxic on injection into normal animals. The action is similar to that of histamine. From one dog dying of intestinal obstruction we withdrew by the citrate method 50 cubic centimeters of blood. A normal dog was then bled sufficiently to permit a transfusion of this toxic blood. The result was a temporary violent reaction similar to histamine poisoning with intestinal cramping, vomiting and purging, respiratory distress and circulatory collapse. The animal apparently recovered in a few hours but 3 days later was found to be suffering from an extensive intussusception at the ileocecal junction produced by violent peristalsis.

We may conclude that there develop from bacterial action in the obstructed lumen toxic substances the exact nature of which is not known but which on absorption into the general circulation exert an action similar to histamine. The toxins are not absorbed in lethal quantities from the normal mucosa but with tissue necrosis from overdistention or strangulation of the bowel the rapid absorption of toxins ensues and is followed by gangrene and peritonitis.

CLINICAL APPLICATIONS

It is apparent that gangrene of the bowel is the chief factor which makes intestinal obstruction such a desperate surgical condition. In any case the type of obstruction encountered will depend upon the mechanical factors in force. We feel that a study of these mechanisms will lead to a more accurate conception of this complex surgical problem.

CONDITIONS PRESENT IN SIMPLE INTESTINAL OBSTRUCTION

1 Simple obstruction occurs most often high in the intestinal tract at the pylorus or in the duodenum as a result of cancer or cicatricial contraction. From these high obstructions there arises a profound disturbance in the absorption of water and sodium chloride. The resulting dehydration and hypochloremia tend to be rapidly fatal. This is particularly true in the pyloric stenosis from peptic ulcer in which hyperacidity and persistent vomiting lead to enormous losses of chlorides. In cancer or any condition of obstruction accompanied by prolonged achlorhydria the chloride losses are small and these cases may actually become moribund from dehydration without appreciable reduction of the blood chlorides. From a clinical standpoint it is also interesting to note that the vicious cycle vomiting which sometimes occurs following a gastroenterostomy is in effect a high intestinal obstruction. In all of these conditions life may be saved and a moribund patient may be prepared to withstand major surgery by the administration of water and sodium chloride intravenously, hypodermically or by any method which permits adequate absorption into the general circulation.

2 Simple obstruction may occur very low in the tract at the rectum or in the sigmoid colon. The low obstruction obviously produces no profound disturbance in the absorption of water and salt. In the absence of bowel necrosis such a condition is compatible with life over a long period of time.

3 Elsewhere in the bowel simple obstruction may occur as a result of neoplasm or fecal impaction. In the small intestine however though the mechanism be simple at the onset the complex loops of bowel and the mesenteric folds almost invariably lead to strangulation.

Clinical experience supports the truth of these statements and failure to recognize these different mechanisms has led to much error in the interpretation of experimental results.

It will be noted that simple obstruction is nearly always the result of obturation by neoplasm or scar tissue. Anything producing obstruction by pressure from outside the bowel is almost certain to cause gangrene.

THE FACTORS CONCERNED IN PRODUCING STRANGULATION OF THE BOWEL

A consideration of the question as to the factors involved in producing strangulation of the bowel is of value in understanding the cause of death in most cases of intestinal obstruction and in securing information to guide us in its intelligent treatment. Our experimental and clinical work has led us to conclude that the chief factors involved are (a) necrosis of the bowel from pressure at the site of the obstruction (hernial ring or constricting band) (b) gaseous distention of the bowel and (c) obstruction of the mesenteric circulation.

Necrosis from pressure It is a very common observation at operation in advanced cases of obstruction that the bowel is necrotic directly beneath the constricting band. This is easily explained. Proximal to the obstruction there is great distention of the bowel which produces constant traction on the constricting band. It is evident that traction rather than the mere presence of the band is the cause because the intestine must at one time have passed under the band without constriction.

The fact that the intestine damaged at the site of obstruction should always be borne in

mund at operation For this reason greatly distended loops of bowel should never be allowed to escape suddenly from the abdomen The traction thus produced may lead to a rupture of the damaged bowel flooding the peritoneal cavity with intestinal contents It is always safer to search for the collapsed bowel and to use this as a guide to the site of obstruction When it is located it should be exposed with greatest care and gentleness Before the band is freed every precaution should be taken to prevent the escape of intestinal contents In desperate cases it is some times safer to ignore the site of constriction and to relieve the obstruction by an enterostomy

Effects of gaseous distention Gaseous distention results from bacterial action on the stagnant intestinal contents This is frequently the most dangerous factor in the entire process and the successful handling of this distention is essential in the treatment of any case That gaseous distention of the bowel can alone produce gangrene and actual perforation was first announced by Kocher (8) in 1895 It has not been sufficiently emphasized by later writers We have made an experimental study of this condition the results of which are now in the process of publication (4) By actual measurement of the blood flow through freshly obstructed loop we have demonstrated that increasing gas pressure in the intestinal lumen results in a proportionate decrease in the rate of blood flow through the bowel wall When the gas pressure equals the animal's blood pressure a complete circulatory stasis in the loop results The ischaemia is noted first and becomes most pronounced along the antimesenteric border where the terminal vessels anastomose We have noted this location of the gangrene and perforation many times at necropsy on dogs with experimental intestinal obstruction

Aside from this effect of gaseous distention it is undoubtedly true that the pressure increases the absorption of toxins Murphy and Brooks (10) have shown that toxic absorption takes place rapidly through the lymphatics of an isolated loop when the toxin is introduced under moderate pressure

That distention of the bowel may exert enormous pressure in the human subject we

have seen strikingly demonstrated in a well advanced case of intestinal obstruction When the peritoneum was opened through an incision 1 inch in length a distended loop extruded itself and though immediately restrained with gauze packs it ballooned out with sufficient force to split all the outer coats down to the submucosa From a consideration of the great pressure which gaseous distention may exert we can easily understand the mechanism whereby gangrene so readily complicates any obstruction of the small intestine

This tendency is greater in the presence of dehydration which causes concentration of the blood and a marked depression of the general circulation With this mechanism added to gaseous distention circulatory stasis in the bowel and tissue necrosis may occur much more readily We have found repeatedly in our animals that support of the circulation by normal salt hypodermoclysis reduces the tendency to the development of gangrene in the obstructed bowel

INTERFERENCE WITH THE MESENTERIC CIRCULATION

The mesenteric circulation is not always involved It is of chief importance in volvulus intussusception and strangulated hernia It is obvious that when mesenteric vessels are compressed the veins will become obstructed sooner than the arteries and for this reason congestion and great swelling will take place This accounts for the copious bloody stools seen in any thrombosis of mesenteric veins If this thrombosis is complicated by gaseous distention gangrene and death from toxemia rapidly follow

GENERAL PRINCIPLES OF TREATMENT

The surgical treatment of intestinal obstruction will depend upon the type and duration of the causative factor An obstruction of simple type unattended by gangrene occurs characteristically at or near the pylorus and is also found in the early stage of any intestinal obstruction

The treatment of pyloric or duodenal obstruction should never be regarded as an emergency surgical procedure Operation should not be undertaken until the dehydra

tion hypochloræmia and starvation have been overcome by the intravenous administration of sufficient sodium chloride glucose and water. Under this treatment the prognosis of pyloric obstruction should be favorable.

In the early stages of any intestinal obstruction the same treatment should be followed except that the operation should be done as soon as the blood chlorides have been restored to a normal level. Here also the prognosis is favorable.

Simple obstruction of the bowel may occur as the result of a localized peritonitis involving any part of the intestine. This is a not uncommon occurrence following appendicitis or pyosalpinx and is best treated early in the process by a simple enterostomy and thorough drainage of the primary infection.

Obstruction of the bowel complicated by gangrene calls for special methods of treatment. If general peritonitis is already present any treatment is hopeless. Without this complication there is a chance to recover even in the desperate case. The following principles of treatment should be observed:

1. The toxemia of intestinal obstruction is closely allied to that of surgical shock; it is not identical with it. For this reason the patients withstand general anesthesia especially ether anesthesia badly and should be subjected to the least possible amount of operative trauma.

2. The operation should always be preceded by the intravenous administration of a considerable quantity of physiological sodium chloride solution.

3. An intestinal anastomosis should never be undertaken in the presence of a great distention of the bowel. The seminecrotic tissue cannot be sutured safely. Furthermore there are fresh surfaces opened for rapid absorption of toxic material and the paralytic ileus which remains prevents adequate evacuation. An additional factor contributing to the disaster is the initial shock of a difficult operation which may be fatal in a very few hours.

4. The gangrenous loop should be excised and a gun-barrel enterotomy performed. When the patient has completely recovered from this operation an intestinal anastomosis can be safely established.

GENERAL SUMMARY AND CONCLUSIONS

1. Acute mechanical obstruction of the intestine is of two types: acute simple obstruction in which there is simple occlusion of the lumen without bowel necrosis and acute strangulation in which the obstruction is complicated by the presence of gangrene of the bowel.

Simple obstruction chiefly occurs high in the intestinal tract at the pylorus or in the duodenum. In this condition death is not due to the absorption of toxins but is caused by a profound metabolic disturbance resulting from three factors: dehydration loss of chlorides causing gastric tetany and starvation. In simple obstruction which occurs low in the large intestine the metabolic functions of the bowel are not markedly disturbed and none of these changes is pronounced.

3. In acute strangulation the factors are all present but are overshadowed by toxemia. The toxin, a proteolytic product from the action of putrefactive bacteria in the obstructed bowel. When absorbed it exerts an action similar to histamine. It is not absorbed from the intact intestinal mucosa but makes its way into the circulation through an overdistended bowel and in the event of gangrene the absorption by way of the peritoneal surfaces is rapidly fatal. In the small intestine practically all obstructions met clinically or produced experimentally are sooner or later complicated by gangrene.

4. In the light of our present knowledge the prognosis of acute simple obstruction should be favorable unless the patient is moribund before treatment is instituted. The metabolic disturbances resulting from dehydration and the loss of chlorides are effectively relieved by the parenteral administration of sodium chloride solution. In obstruction complicated by gangrene this treatment is of value in that it supplies fluid and chloride, increases kidney elimination and supports the general circulation. The toxemia however is not relieved by such measures. It is obvious that once a sufficient dose of toxin has been absorbed death is inevitable. The process must be arrested early. The general principle of surgical treatment have been outlined with these points in mind.

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THE MANAGEMENT OF CHRONIC ENDOCERVICITIS

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CHRONIC endocervicitis is not a subject upon which one can be startlingly original but I make no apology for again presenting this timeworn theme. As Sir Berkeley Moynihan once aptly said in another connection much paper and much poverty may co-exist and it is not the settled problems of medicine about which much is written but rather those upon which light still needs to be shed.

Endocervicitis as a clinical entity has long been recognized. Its persistence and its intractability to treatment have long been acknowledged. But its full importance is not yet realized nor is it realized that the unsatisfactory results of most methods of treatment are due to the fact that they are directed at the manifestations of the disease rather than at its underlying pathology.

Let it be said at the outset that endocervicitis always demands treatment. This most frequent of all gynecological affections is never a trivial thing. It is potentially serious even when it manifests itself as an apparently local disease. Once it is established a whole train of symptoms may follow arising not only from the cervix but from the uterus and the upper pelvis whence the infection spreads by continuity of tissue or by lymphatic channels.

Thus Curtis has pointed out that the virulent strains of bacteria found in certain cases at least make spontaneous postoperative and postpartum infections eventualities to be dreaded. The work of Sturmordorf, Rosenow, Langstroth, Moench and others would seem to lend both experimental and clinical proof to the theory that the histology and lymphatic structure of the cervix warrant its consideration as a frequent focus of systemic infection. I am not of those who accept this supposition unreservedly but it is folly to deny that in certain cases the sequence of cause and effect is too clear to be overthrown.

Finally, there is no doubt that endocervicitis is a condition to which may be truly applied that much abused word *precaucious*. Out of the welter of theories centering about the vexed subject of the etiology of cancer certain indisputable facts emerge. Cancer is always due to the abnormal growth of normal cells and trauma and long continued irritation play a definite part in its production. The relationship of endocervicitis is therefore quite clear. Trauma is a predisposing cause of endocervicitis; the disease itself furnishes the necessary irritation and at least one manifestation of its pathology

—erosion—is akin to abnormal cell formation. Culbertson and Eden have pointed out that certain types of erosion show an extensive proliferation of cells, the development and arrangement of which clearly place the disease on the borderline of malignancy, and Matthews has likewise called attention to the fact that it is but a step from the extreme cell proliferation with orderly arrangement which occurs in marked hyperplastic cystic endocervicitis to the disorderly arrangement with embryonal cells found in true malignancy. The soil is plainly ripe for the transition and the actual sequence has been proven too many times to make the causation any longer a matter of doubt.

It is likewise beyond dispute that any condition which can terminate as endocervicitis can in pathology of the upper pelvis in spontaneous postoperative and postpartum infections or in systemic focal infection and which has in itself the potentialities of a transition to malignancy is not a disease to be ignored or to be regarded lightly.

The most important point in the management of endocervicitis is an accurate comprehension of the conditions which must be met. No one method of treatment is applicable to all cases, but any method will fail which does not take into consideration the actual structure of the cervix and the pathology which that structure makes possible.

Two most important considerations in the anatomy of the cervix must therefore be emphasized at this point. In the first place the cervical mucous membrane is composed of complicated racemose glands which empty through small ducts into the canal and it is thrown into definite folds radiating from a central line. In the second place the lymph current may be traced from its origin in the cervical and corporeal mucosa through minute funnel-shaped ostia directly to the myometrium. Here it branches into an extensive capillary network which penetrates the uterine musculature later draining into the main collecting channels which course parallel to the uterine and ovarian blood vessel at the base and top of the broad ligament.

The complicated structure of the cervix makes it perfectly evident that its mucosa is

peculiarly susceptible to infection and peculiarly capable of permitting an infection which has once established itself to penetrate deeply into its corrugations and to remain latent for long period of time. It is equally evident that the lymphatic structure of the pelvis furnishes an ideal route for the upward extension of whatever infection has once gained a foothold in the lower genital tract.

Moreover it must be emphasized that endocervicitis is essentially an infectious disease. It is the result of an infection not the result of a laceration though the two conditions are so frequently coincident that the one can scarcely be considered without the other. The laceration undoubtedly acts as a predisposing cause the ever open which practically always accompanies it permits the ready introduction of organisms the raw surfaces furnish a suitable soil for bacterial growth and the formation of scar tissue interferes with the lymphatic drainage and keeps up a constant unhealthy congestion but infection must enter by some method before the disease can be established.

These then are the facts which must be faced in every case of chronic endocervicitis. We are dealing with an essentially infectious disease most often of gonorrhœal origin in which the organisms tend to burrow deeply into tissue peculiarly fitted to harbor them over long periods of time and in which there is no tendency to spontaneous cure but rather a tendency to upward extension by continuity of tissue or by lymphatic channel. These conditions in the great majority of cases are further complicated by the presence of more or less extensive cervical lacerations. What mode of treatment shall we adopt? Is any one method applicable to all cases?

Prophylaxis is obviously the keystone of the arch. The best way to handle chronic endocervicitis in addition to the prompt treatment of the acute form is by preventive measures. Since it is so constant an accompaniment of cervical lacerations it is plainly wise to treat such laceration before they become infected though whether this means that they must be repaired immediately after delivery as advocated by Lmge and others is still a disputed matter. Immediate repair

may give good results in the hands of the expert obstetrician who does his work in a hospital under every aseptic precaution but in the hands of the average practitioner such a procedure would probably be fraught with disaster. The intermediate operation therefore or repair within a few months after delivery is a wiser routine procedure. The important point however is that the lacerations no matter what plan of treatment is adopted must not be ignored. There is no longer any valid excuse for the old method of deferring treatment until the patient is past the childbearing period. The potentialities for permanent damage to the pelvic structures are too great to warrant any such course as that. Postnatal care is as important as prenatal observation and many cervical lesions are easily corrected soon after delivery but if neglected may later need radical treatment.

As far as the actual treatment is concerned certain methods may be promptly disposed of. Even in mild cases local applications are of small value. Only when the organisms are still superficial would such a treatment be warranted and if one remembers the speed with which bacteria travel the futility of such methods in the average case is at once apparent. Even douches are of use only in cleansing the vagina of irritating discharges and lessening local discomfort; they can have little effect on the disease itself.

Autogenous vaccines are only occasionally helpful. Diathermy, ionization, suction intrauterine lavage, alcoholic injections injections of pastes and salves, these and similar measures are not always logical; they do not give uniform results and many of them are not free from danger. Curettage is rarely indicated. The trouble lies in the cervix, not in the uterine mucosa, and thorough curettage of the cervix with its complicated glandular structure not only is a practical impossibility but often leads to upward extension of the infection.

Radium cannot be dismissed quite so cavalierly in view of the excellent results reported by several authorities, notably Arthur Curtis of Chicago who first suggested its employment in endocervicitis. For my own

part I should hesitate to advocate the general employment of such an agent. If it is used it must be strictly limited to those cases in which it can be definitely demonstrated that no active or latent infection of the tubes is present and even to an expert such a decision is not always easy to make in the face of a badly infected cervix and the possibilities of an upward extension of the infection.

Cauterization and surgery then remain as the two methods most generally applicable. Mild cases of endocervicitis, especially those seen within a few weeks after delivery and characterized by superficial lacerations and mild erosions, are handled very satisfactorily by cauterization with the small nasal cautery. This is a feasible office procedure and may be done either without anesthesia or with the application of a 4 per cent cocaine solution. Multiple linear incisions are made with the tip and it is surprising to see how quickly a diseased hypertrophied cervix can be converted into a normal healthy organ. Usually one cauterization is sufficient but the procedure may be repeated if necessary.

Equally good results are secured when the disease is more extensive if a similar but more radical procedure is carried out under anesthesia in the hospital and a larger cautery is used. It is important to emphasize however that the cases must be properly selected. Cauterization is not a panacea to be promiscuously applied to all patients with endocervicitis. It is curative only in the milder infections; before extensive fibrosis occurs. In the deeper types it must be done very cautiously for if the incisions are sufficiently radical to strike at the real seat of the infection and the whole cervical mucosa is thereby destroyed stenosis of the canal is almost inevitable and the patient's last condition will be worse than her first.

In this connection Matthews' suggestion is a good one that the indications for cauterization may be widened if it is done unilaterally that is if one lip of the cervix is cauterized and permitted to heal before the other is attacked. It goes without saying that graduated dilatation must be resorted to promptly if there is the slightest evidence of cervical stenosis after the cautery has been used.

If the endocervicitis has originated in lacerations of marked degree some sort of surgery is inevitable. Trachelorrhaphy is the preferable procedure because it restores the normal anatomy of the parts and leaves the uterus protected against bacterial invasion by a cervix of normal length and size. However, measure must first be taken to eliminate the infection. This is best achieved by a preliminary course of treatment including rest in bed, postural exercises, general hygienic measure, local applications and douches and cauterization and puncture of individual cysts is indicated. It is surprising to see how by these means the size of the cervix and the inflammatory reaction can be reduced and how often a seemingly hopeless case is thus rendered quite fit for a simple repair operation. Trachelorrhaphy often fails just because the pre-operative measures are omitted, a point long ago emphasized by Emmett but frequently forgotten by the modern gynecologist.

When even after such a course of treatment truthfully carried out trachelorrhaphy does not seem to promise results the gland-bearing area of the cervix must be removed by the Schroeder or the Sturmdorf technique, my personal preference being for the latter. These operations are preferable to amputation because they preserve the anatomy of the cervix and rid the body only of that portion of the organ in which the infectious process is located. The results are extremely good provided the operation is done before marked hypertrophy and fibrosis have occurred and the incision is carried high enough to include the entire area affected.

All of the procedure we have thus far discussed permit subsequent pregnancies to occur practically without complications, an important consideration in young women. The results of amputation of the cervix are however quite different. Sterility is frequent thereafter and if conception does occur abortion is likewise very frequent if the pregnancy goes to term the dystocia may be very severe. Menstrual irregularities and vague pelvic disturbances are also prone to follow amputation and for these reasons it is well to employ it only as a last resort in women

in the childbearing period when the lacerations are extensive and the infection has proved intractable to other methods of treatment. In women beyond the childbearing period these considerations are naturally not so vital but even then I do not advocate its performance without a careful consideration of other possible treatments.

Curtis has recently reported brilliant results in gonorrhoeal infections merely by keeping the patient away from her original source of contamination, his idea being that many times we may regard as a recrudescence of a chronic infection what is really a reinfection. The method certainly has possibilities in endocervicitis of gonorrhoeal origin though it is useless with irresponsible and uncooperative patients whose number unfortunately is legion.

SUMMARY

1. Endocervicitis is an infectious disease which does not tend to cure spontaneously and the sequelae of which may be extremely serious. Every case therefore demands prompt treatment.

2. Any treatment to be successful must be directed toward the underlying pathology rather than toward the manifestations of the disease and this pathology cannot be clearly realized unless there is an accurate comprehension of the histology of the cervix and the lymphatic circulation of the pelvis.

3. Local treatment is very unsatisfactory and diathermy, ionization, alcoholic injections and similar measures give only partially satisfactory results and are not free from danger. Iodine often gives excellent results in selected cases but is too dangerous to be employed routinely.

4. Prophylaxis especially soon after parturition will avert a large proportion of cases.

5. According to the conditions present cauterization, trachelorrhaphy, the Sturmdorf operation or complete amputation must be done although the latter procedure should be avoided whenever possible.

6. Any surgery is best preceded by a preliminary course of treatment the object being to reduce hypertrophy and inflammatory reaction in the structure and to restore the normal relation of the parts.

SURGICAL DRAINAGE OF THE SEMINAL VESICLES AND PROSTATE

ITS INDICATIONS TECHNIQUE AND RESULTS

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WITH the development of a broader conception of possible focal infection within the genito-urinary tract apart from the so-called venereal conditions the problem of treating acute and chronic infections of the prostate and seminal vesicles that do not respond to ordinary palliative methods again demands interest and attention. As a substitute for surgical drainage the Belfield procedure direct application through the ejaculatory duct and injections directly into the substance of the gland with various drugs have all been practiced in an attempt to cope with a persistent infection. Kolnick's careful studies of the changed histology of the vas following these injections and a statistical survey of clinical results presented by Kretschmer before the New York Academy of Medicine would seem to demonstrate that vasotomy does not accomplish all that we had hoped and is not 100 per cent effective. Injections into the substance of the gland and vesicles is not entirely without value and offers a field for further study. Some years ago at Bellevue Hospital Dr. J. J. Valentine carried out a series of injections with a serum devised by Dr. Miguel Cuno. The results were striking but the method lacked scientific foundation and was dropped among other reasons for want of money to continue the essential pharmacological studies involved.

In the *Journal of Urology* in 1925 Dr. Thomas Stellwagen reported a large series of cases in which 150 injections of aqueous isotonic iodine solution were made. This solution liberates free iodine in the tissues to the amount of 3 per cent. In a recent personal communication Dr. Stellwagen tells of 14 more cases treated by injection of the vesicles. The results were uniformly good and 1 year after discharge no bone pathology was present and no new focus had appeared in the lower genito-urinary tract. The essential nature of these injections is a protein reaction and sensitization.

There can be no dispute as to whether the seminal vesicles and prostate will harbor an infection indefinitely. The very practice of massage injection vasotomy irrigation etc. all indicate an attempt to deal with this infection. The objection to vesiculotomy was that all pockets were not effectually removed and to vesiculectomy that it was invariably followed by sterility and in some cases impotence. Several years ago Huet showed experimentally that bacteria were present in the seminal vesicles of healthy animals and he was also able to find the specific organisms in the secretions of the vesicles in animals dying of acute sepsis.

It is variously estimated that from 4 to 10 per cent of all infections maintain an active focus in and about the vesicles. These are the cases that have troubled us and they bring us therefore to a consideration of the merits of operative procedure.

Discussion is also pertinent at this time because of the importance attached to latent prostatic infection in a variety of conditions. Von Lückum of the Mayo Clinic in a study of the focal scope of prostatic infections has demonstrated the relationship between these infections and a variety of disorders including in their relative frequency such remote disturbances as arthritis spondylitis calcaneal spurs peripheral neuritis sciatica and fifth nerve disturbances, myalgic and neuromuscular pains, eye infections—chiefly iridocyclitis and neuroretinitis, secondary anemias, vasomotor skin conditions such as urticaria and angioneurotic edema, erythema multiforme, dermatitis, fever of the so-called undetermined temperature, backaches, abdominal pains chiefly of the lower abdomen, functional gastric complaints and peptic lesions of the stomach and duodenum. We must therefore accept this problem by which the relationship of focal prostatic infection and urinary tract disease is linked up more closely with general

systemic disturbance and be prepared if justified to institute radical measures in the same degree as would be used in the handling of tonsillar antrum and sinus and dental infections for bacteriologically focal infection of prostatic origin is essentially the same as that from teeth and tonsils.

Hitherto the failure to locate gonococci within the vesicle or prostate of patients operated upon was deemed of some significance. We know now that in patients who give no history of a previous urethritis an infected prostate will show the same strain of streptococci as is found in periapical lesions, tonsils and sinuses. Inoculations in this group of cases have shown prostatic localization and selectivity in 70 per cent of the male rabbits injected, whereas the control injections in female rabbit showed less than 10 per cent localization in the cervix.

Therefore with this conception of the problems of a focal prostatitis embracing this type of infection not only in a primary form but secondarily as the result of a gonorrhoeal infection consideration should be given to a rational method of drainage in cases in which it may be deemed advisable.

Interference with drainage may be epitomized as the basis of symptomatology in all secreting viscera but the seminal vesicles for some reason have been considered as insulated against the necessity of surgical drainage. Interest in seminal vesicle and prostate operations to remove foci of infection has shown only sporadic activity. Some 30 years ago Eugene Fuller of New York performed a number of drainage operations and although he reported favorable results his conclusions were more enthusiastic than accurate and he must be credited solely with drawing attention to this important field. We know that he could not have entirely drained the vesicles with the operative procedure followed. Later about 1910 or 1914 Squier was most active and 5 years later Cunningham of Boston but this enthusiasm has subsided with the demand of an increasing private practice and withdrawal from active clinical work. It is true that seminal vesicle infections particularly in their joint manifestations have a certain economic significance. Gonorrhoeal rheuma-

tism in particular seems limited to the type of patient frequenting the municipal hospital and in an average or high grade practice one rarely meets incapacitating joint infection. Then too operations for drainage of the prostate and seminal vesicles suffer a disfavor in common with methods for perineal prostatectomy because of the anatomical difficulties involved and it is perhaps unfair to expect recognition of the value of this method of drainage from those of us who see in perineal prostatectomy nothing but a technical operation which offers no advantage over suprapubic methods of removal. In other words it is difficult for one who has not observed the increased ease of convalescence after perineal prostatectomy to comprehend how through a perineal wound complete dependent drainage is secured and an unusual facility provided for irrigation and the other details of surgical after treatment.

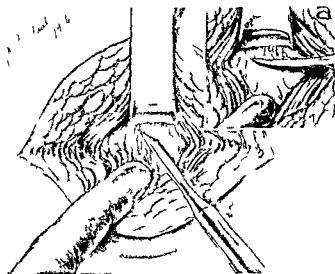
In the past 5 years at Bellevue Hospital there has been an average of 88 patients admitted yearly suffering from gonorrhoeal rheumatism. The average hospital stay of these cases was 38 days. In the City Hospital there has been an average of 3 cases yearly with an average residence of 42 days. Comparing these with the residence of about 140 cases operated on we find that the term of hospitalization is reduced to an average of 3 weeks and in 35 per cent of the case to 2 weeks. In addition routine treatment is facilitated and improved results are obtained in the form of relief from symptoms in much shorter time than with the usual form of therapy by means of casts, vaccine and prostatic massage.

The question therefore in rheumatic cases is whether operation for drainage of the prostate and vesicles is effective in diminishing the hospitalization of these cases without unduly increasing the risk and making it greater than that found in some other form of treatment.

Exclusive of the tuberculous type cases for operative measure may be divided into 3 groups: first acute suppurative processes involving the prostate and vesicle and drained commonly as prostatic abscess; second a group with acute or chronic joint changes;



1 Showing the division of the central tendon just before the bulb has been retracted anteriorly. The tractor in place, testicles held by gauze, pole and line of incision.



2 Showing the prostate covered by the fibers of the urethralis muscle and the method of removing these fibers from the surface of the prostate. The bulb is retracted anteriorly, and the edge of the levator ani can be seen on either side. In the insert the prostate is shown after these fibers have been removed and the organ has been partially denuded. It will be seen that the characteristic white fascias have come to view.

and third a group comprising the variety of systemic disturbances quoted above in which a definite prostatic infection has been demonstrated. In the first group there is usually no difficulty in demonstrating an immediate relationship between the original gonorrhoeal infection and the onset of symptoms. In the other groups one must arrive at the prostatic infection by exclusion inasmuch as teeth and tonsils are far more likely foci and should first be eliminated. In this respect the association of a double infection is of importance and often the removal of one focus lifts the strain from the recuperative powers of the individual so that he overcomes the second. Arthritic cases treated at Bellevue Hospital before being placed in a cast are given a careful examination for dental and tonsillar infections. When such foci of infection are removed the prostatic infection often subsides to such a degree that the joint symptoms disappear.

The connection between perineal and ischio-rectal abscess and chronic infection in the seminal vesicles is a very important one and very frequently overlooked. Several years ago Herman published a resume of several cases of pelvic suppuration in males and at that time stated that the seminal vesicles were undoubtedly the starting point of the

infection. Ischio-rectal abscess is rare in the female unless secondary to a rectal lesion and the type of case seen in the general hospital ward is seldom met with in private practice. The course of these cases is a short one. The patient enters the hospital with a swelling over the ischio-rectal space which is incised and the patient is discharged. The history is brief and the study of the cases minimal. Ischio-rectal abscess is treated most lightly in the textbooks on diseases of the rectum in fact in considering the etiology each author seems to have borrowed it from a fellow author because almost to the word reference is made to fishbones fragments of paper and unusual traumatism such as prolonged walking or horseback riding as exciting causes. In a study of the termination of 100 of these abscesses Sejong reports that 35 per cent of his series perforated the urethra in indication that the infection burrowed forward and penetrated the dense capsule of Denonvilliers. These infections start in the tip of the seminal vesicles or in some perivesicular area and instead of going forward burrow posteriorly. Added infection with bacillus coli occurs and it may travel through the superior pelvirectal space pushing the peritoncum before it and making an opening into the right

charge the prostate remains swollen and tender and the joint symptoms are severe drainage should be instituted

In the past 6 years we have operated on 64 cases of acute prostatitis and seminal vesiculitis. In addition 14 cases of chronic seminal vesical infections have been treated by epididymectomy. Twelve cases of extensive peripelvic prostatic suppuration have come to my attention and have been operated upon. These last cases had developed perirectal and superior pelvic abscesses. It has been difficult to obtain follow up information from the patients with joint affections as most of them were municipal hospital and state hospital cases. The immediate effects of operation in the other cases have been (1) disappearance of pain and swelling (2) subsidence of fever and (3) decrease in size of prostate and perivesicular swelling and tenderness.

To date we have had no recurrence of prostate symptoms and no urethral symptoms. Unfavorable results were not noted except that in 6 cases the patients developed severe chills and became very toxic. The latter afterwards had brisk easily checked hemorrhage from the wound. In none of the cases did a fistula develop.

In comparison with the cases of prostatic abscesses which ruptured into the urethra and developed prostatic diverticula with their annoying symptoms this form of treatment in my opinion is to be preferred. Following operation in the rheumatic cases striking results have been noted. In about 80 per cent of the cases there is always a disappearance of pain joint swelling disappears and function returns. The relief from pain is sometimes unbelievably spectacular. Occasionally if drainage diminishes or is interfered with the symptoms may again appear but this condition can be relieved by adequate dressing and probing of the wound. In cases in which X-ray examination has shown actual cartilaginous destruction and bony hyperplasia a return to normal cannot be expected. The acute process within the joint subsides and there is a gradual return to function. If the symptoms do not subside some area of infection probably was not adequately drained.

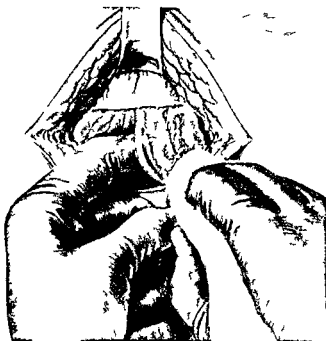
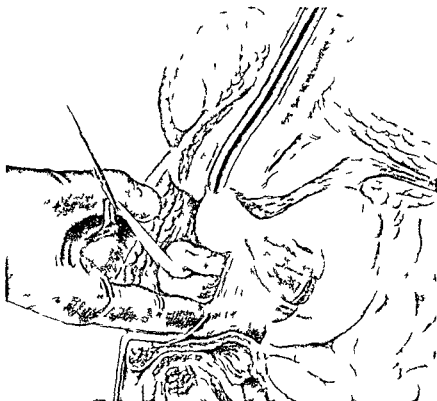


Fig. 4. Prostate exposed and bulb retracted anteriorly. The fascial planes covering the vesicles have been removed and the vesicle is being separated by gauze dissection from the ureter and ampulla.

Attention should be called to the existence of seminal vesical infection in cases of enlarged prostate. The persistence of this infection after prostatectomy may account for the delayed convalescence in these cases. In this connection at the International Urological Congress in Rome in 1924 Sir J. Thomson Walker described a method of transvesical vesiculotomy and vesiculectomy. He called attention particularly to seminal vesiculitis in senile enlargement of the prostate due to septic catheterization and stated that persistence or urinary infection after prostatectomy was due in many cases to vesical infection. During convalescence from the prostatectomy or after the bladder wound has healed in such a case there is a rise of temperature with perineal and rectal pain. If normal urination has been reestablished there is often some difficulty and there may be retention of urine. Palpation through the rectum shows that the seminal vesicles are enlarged and tender. A sudden discharge of pus in the urine is followed by a drop in the temperature and disappearance of the symptoms. Recurrence of the attack may require perineal drainage. Sir J. Thomson Walker believes that vesiculectomy is indicated at the time of



I n r b t l t n, th m t l f l at th l l l
 t n h l e l p p d d t l l d t l l t d t l l
 N t th dja t p t o f th rd d t

operation if the infection is known to be present and that the vesicle should be removed simultaneously with the prostate. If the condition of the patient is unsatisfactory, however, the vesicle should be laid open and allowed to drain into the bladder. In case of chronic infection contributing to other symptoms, such as joint infection and referred or distant pain, operation should be the last resort in treatment and sound judgment should be exercised in the selection of case.

In extensive studies of infection in the genital system Baumgarten was able to show that tuberculous spread in the direction of secretion. From the original infection the process is borne by the blood stream from the epididymis to the seminal vesicle and the prostate. This is an important point in explaining the etiology of persistent vesical infection in which the condition accompanies or follows an earlier epididymitis. The infection apparently

remain existent in the epididymis and either along the lymphatic or directly through the blood stream a degree of infection is delivered into the vesicle which in turn produces the main symptomatology.

In such cases removal of the original focus may be very beneficial and is quite likely to cure both the vesical and prostatic infection. I have in cases so operated upon in which the epididymis had been involved primarily and showed slight thickening and nodular formation. Following an epididymectomy there was a complete disappearance in every case of the prostatic and vesical infection and a disappearance of all the systemic manifestation due to the infection. In the cases the deferens was usually blocked off and the epididymis itself showed a marked degree of nodular thickening with fibrosis. In several cases some thickened areas in the specimen were also removed. A case illustrating this type is as follows:

D J N 31 years of age referred by Dr J M Bolster of Providence Rhode Island. General health had always been good except for two attacks of gonorrhoea 7 and 4 years ago. The original attack was complicated with right epididymitis which subsided without operation. Convalescence at this time occupied 14 days. Epididymitis slowly subsided. The second attack occurred 4 years ago with a return of the epididymitis and marked prostatic and seminal vesicle symptoms. The epididymitis was treated by support and hot applications, no treatment was given the prostate or vesicles. Discharge continued for about 6 months following disappearance of epididymitis and has not responded to the usual methods of treatment. Recently the patient has been unable to gain weight and is about 20 pounds below normal. He suffers from moderate depression and lack of strength and complains of pain in the back, slight difficulty on urination and a moderate degree of functional impotence.

Examination showed blood pressure systolic 90 and diastolic 60, urine specific gravity 1012, slightest possible trace of albumin, no sugar or casts, numerous pus cells and epithelial debris, no red blood cells. Rectal examination: Prostate is boggy and swollen. Both seminal vesicles are enlarged, particularly the right one which is nodular and surrounded with considerable perivesicular thickening. Smear of secretion expressed from prostate shows numerous pus cells. Vesiculectomy was done at St Joseph's Hospital Providence. The vesicula was dissected away from the testicles. The tissue was hard and cicatrized. Most of the normal tissue had been replaced by organized exudate. An uneventful recovery followed. The patient immediately noted an improvement and after 6 months his condition was much improved. He had gained 11 pounds in weight and showed a marked increase in strength and ambition. Seminal powers were normal, the prostate was firm and the vesicles were non-palpable. The patient was seen 2 years after operation and had had no return of symptoms. His general condition was excellent.

As regards recurrence of symptoms after operation it has been observed with respect to all the complications in neisserian infections that the identical complications are likely to ensue. In other words if joint symptoms are met with in an initial attack joint tenderness is noted in each recurrence. So too with an epididymitis which if present with the original infection may be expected to give symptoms with each recurrence.

As to the pathology it would seem that the essential factor in these conditions is the extension of infection along the ejaculatory ducts and into the perivesicular and periprostatic tissue. Resolution undoubtedly occurs in

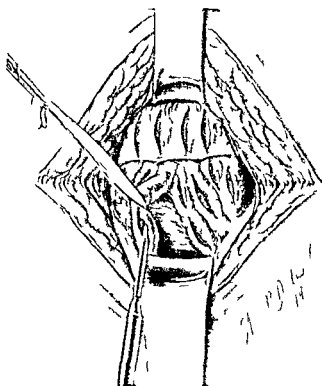


Fig 6 Showing multiple incisions in the prostate vesicles ampulla and vas

over 96 per cent of the cases of perivesiculitis and periprostatitis as is evidenced by the frequency with which many of these cases come to operation. Adhesions in the inflammatory area compress and contract the vesicles and this in itself while accounting for a great proportion of the cases showing symptoms of vesiculitis undoubtedly prevent the extension of subsequent infections. In a moderate number of cases however local resistance does not develop, a low grade of inflammatory process sets up and slowly produces an exudate. The periprostatic and perivesicular fascia becomes invaded with a thick exudate which as it is resolved causes the fascia to become rather leathery. If the process extends forward the trigone itself may become involved and as resolution becomes complete the trigone contains a considerable amount of connective and scar tissue which interferes with its function. A cystoscopic examination in these cases is usually negative except for a slight congestion of the bladder mucosa. In other cases the infiltration may be sufficiently extensive to involve the urethral orifice. Mathé has so reported a

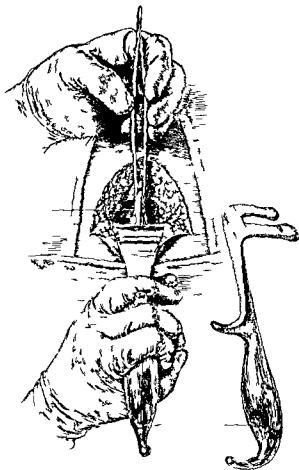


Fig 7 Showing dissection of the prostate gland and seminal vesicles.

case and numerous instances are seen in tuberculosis.

The lesion caused by an inflammation may in very light grades be confined in some cases to the epithelial lining of the sac. In more severe ones it may cause a cell infiltration into the walls of the sac occasioning in recent cases a tumefaction of the walls and in long-standing ones a sclerous condition. In the more extreme case the inflammatory changes invade the loose connective tissue round about the seminal vesicles. In severe cases this perivesical invasion may be sufficient to fill up the entire postprostatic rectovesical space. Under such conditions the inflammatory exudate generally infiltrates forward into the fibrous capsule of the prostate encasing that organ in a hard layer of incrustation. In this type it is impossible by rectal examination to

distinguish the prostate or the seminal vesicles as all these organs lie so embedded in the inflammatory effusion that nothing but a large mass can be felt. Commonly instances of this description are wrongly considered to represent great inflammatory enlargement of the prostate whereas in reality as a dissection will show the prostate itself is not only not enlarged but as a rule somewhat diminished in size on account of the outside pressure. In chronic inflammation if there is no perivesicular involvement the seminal vesicle is apt to be distended and its walls somewhat thinned and hardened by sclerous fibrous changes. Under such conditions there is a mucopurulent intravesicular secretion which may be abundant. In some of these cases granulations spring up over parts of the cavity of the sac occasionally giving rise to hemorrhages which may be extensive enough to fill the sac with blood clot.

A recent chronic perivesiculitis comprises a round cell and serous infiltration with here and there in severe cases little pus foci which may under aggravated conditions coalesce forming abscess cavities which may act as has been described under acute condition. As these surrounding inflammation become of long standing fibrous tissue takes the place of the round cell and the serous exudate are reabsorbed. In many instances of chronic seminal vesiculitis resolution has taken place in connection with the lining membrane of the sac the only lesion remaining being the perivesiculitis.

In operations on the seminal vesicle it is important that the operative approach be made in such a way that the diseased organ are well exposed before any trauma results. In view of the close anatomical and functional relations between seminal vesicle and prostate it is desirable to expose both organs and make them accessible for direct examination. The inaccessible location of the seminal vesicles between the soft parts of the male pelvis and the anatomical and technical difficulties of perineal operations make surgeons avoid the operations.

Several operations are described for the removal of the seminal vesicles. The first operations from above (a) suprapubic (b) inguinal and (c) transvesicle second operation

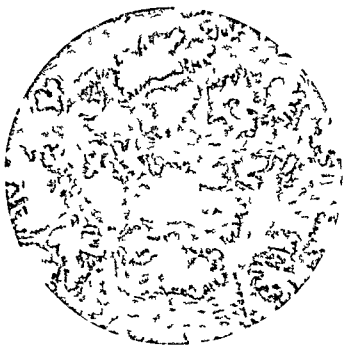


FIG. 8. Section of prostate removed at time of operation showing definite adenomatous change apparently secondary to chronic infection.

ations from below (a) perineal and (b) ischio rectal

In operations from above the peritoneum must be pushed back from the bladder and the seminal vesicle must be found posterior to the bladder. In the operations from below the rectum must be separated from the bladder and the seminal vesicles located in the space between these two structures. The operation from above is dangerous on account of the fact that it is difficult to avoid trauma to the peritoneum. It is easy to separate the peritoneum from the bladder if the midline position is maintained but quite frequently the separation of the ducts causes difficulty and accidental rupture into the peritoneal cavity is fairly often reported. Another drawback to this operation is the unsatisfactory exposure which makes it difficult to recognize changes in the vesicles in the depth of the wound. Drainage is also unsatisfactory. The perineal operation is technically very difficult and there is danger of trauma to the rectum. The surgical wound heals well and the mortality is less than with the operation from above. A review of the operations for tuberculosis shows a mortality of 5 per cent with the method from above and 9 per cent with the method from below.



FIG. 9. Extreme dilatation of vesicles with extensive fibrosis of ampulla and both vasa. Reduced one fifth.

The inguinal operation should be discarded entirely as impracticable. The transvesical operation is also undesirable unless it be combined with a prostatectomy and the need exists for draining the vesicles at the same time.

The operative approach through the ischio rectal fossa is used by several operators and is satisfactory. For the removal of tuberculous vesicles this route is particularly recommended. I described this in detail several years ago in *SURGERY, GYNECOLOGY AND OBSTETRICS* together with drawings showing the method used. The patient is laid on his abdomen and a longitudinal incision about 10 centimeters long is made parallel to the middle line on the side of coccyx and anus. This corresponds to the extent of the ischio rectal fossa. The fat of the ischio rectal fossa is removed and the levator ani muscle exposed. This is divided with an incision at least 5 to 6 centimeters long. Then the fascia which forms the sheath around the rectum and bladder is cut in a line corresponding to the longitudinal axis of the intestine at the border line between rectum on one side and the bladder or prostate on the other side. This point is marked by the veins of the vesicoprostatic plexus and the incision is made on the dorsal side of these vessels. Two fingers are introduced into the slit of the fascia and the rectum is lifted from the bladder. When this is pushed aside one seminal vesicle is brought into the wound and may be handled adequately.

The technique for perineal drainage of the vesicles was originally described by me some

5 year ago and is in many ways a modification of procedure formerly used by others.

It is most important to use the position advised by Dr. Young and called by him the exaggerated lithotomy position. A fluted board is most satisfactory for maintaining the patient in this posture. If this is not available, however, the patient should be brought well forward on the table, shoulder clamps should be fixed in place and the sacrum elevated on a pad at least 5 inches thick. The buttocks are then pulled out over the edge of the table—this is most important in that it permits the carrying out of posterior retraction. The sound is inserted into the urethra and held in position by the assistant. The incision runs from a point superficial to the ischial tuberosity and is carried in a curved line the center of which should correspond to the point at which the urethra leaves the bulb to enter the prostate. The incision is carried fully $\frac{1}{2}$ inch deep in the center. The lateral fossae are then dissected free by blunt dissection. At this point careful search should be made for the characteristic fibers of the central tendon. This I consider one of the most important features of all perineal surgery. Proper and accurate division of this tendinous structure releases all the perineal muscle, prevents bleeding and greatly facilitates the procedure. As the tendon is divided the bulb retracts anteriorly, the transverse perineal muscle is released and the apex of the prostate comes into view.

The sound may then be removed and a vesical tractor introduced. There are several types of these available. The prostate is elevated into the wound and dissection of the fibers of the recto-urethralis muscle begun. This muscle lies between the rectum and prostate and hugs the capsule of the latter. If dissection is begun at the apex close to the urethra and completely carried out until the capsule of the prostate is identified the danger of injury to the rectum will be avoided. It is possible to introduce a finger into the rectum as a guide but as it endangers asepsis it is not to be advised. By blunt dissection alternating with the division of the fibers with the scalpel the major portion of the muscle is removed and can be retracted. This brings

the body of the prostate into view and with the blade of the retractor or a sponge the entire surface of the prostate can be exposed.

The fibers of the levator ani muscle come into view at this time and some of the vessels seem to blend with the fibers of the recto-urethralis. In general, however, the direction of this muscle is anterior and posterior. It can be lifted from the surface of the prostate with the index finger and at the same time the finger can be swept around until the vessels on either side of the gland are free. At this point care should be taken to recognize the existence of several fascial planes constituting the capsule of Denonvilliers. With delicate dissection this capsule can be divided and one plane made out extending posterior to the anterior wall of the retrovesical space. After division of this first layer a second layer should be identified and stripped back to the same point. Two fingers should then be inserted into the space and the vesicle is felt stretched out to either side on the base of the bladder. Occasionally a thin layer surrounds them in this position and can be broken through with the tip of the finger. Incision is thus begun. The organ will stand a severe amount of traumatism and they are seldom ruptured in the process of enucleation. A gauze sponge on a holder is of assistance in the enucleation process and in drawing the entire group of retroprostatic tissues forward where the bladder separation of the vesicle can be completed under guidance of the eye. There is seldom any danger of injuring the vesicle themselves. Inflammatory changes usually take place in the neighborhood of the ampulla and between the vas and the vesicle in this area. In the completion of the dissection the vas is easily ruptured and if this occurs it should be tied off. Vesiculectomy or vesiculectomy may then be done according to the special demand of the operation. Vesiculectomy seems quite effective provided all cavities are thoroughly destroyed. If there is much inflammatory change around the ampulla and vas as is usually noted a small incision should be made here and in addition the prostate may be liberally incised. Often time the prostate will be reduced to half the size following this incision.

Two gauze wicks are then inserted into the retrovesical space the vesicles replaced and two bits of rubber tubing inserted together with the drains. It is seldom necessary to tie a single vessel. This is particularly so if accurate dissection of the central tendon has been made. The tractor is removed the free edges of the levator ani muscle are brought together with a double suture of chromic catgut and the skin wound is closed with interrupted sutures. This technique differs mainly in the retraction of the levator ani muscle. In other procedures this muscle is cut and although more room is thus secured not so good an operative result is obtained. No serious complications may be looked for. Retention is relieved easily by catheterization and bleeding—which seldom occurs—may be controlled by packing. The gauze is removed on the second day and the rubber tubes held in place. These should be kept in position for 5 or 6 days and the cavity irrigated twice daily during this time. Patients are allowed up on the eighth or ninth day and the sutures removed as soon as possible. The edge of the wound usually heal firmly by the third or fourth day and the center of the incision is kept open for drainage purposes.

In my opinion it would seem that we are eventually coming to the point of view that suppurating complications of venereal infections will be considered from the surgical standpoint. This has already taken place as regards epididymitis and it is recognized that the possibility of sterility is much less likely if an epididymis is drained provided it does not quiet down after a reasonable time. So too with attacks of acute prostatitis, prostatic abscess and seminal vesiculitis. Unfortunately the marked diversity of opinion as regards perineal prostatectomy influences perineal operations and perineal procedures. Then too the incidence of impotence and other functional disturbances following an operation are always attributed to the operative procedure itself. It does not seem to me that the incidence is greater in cases so operated upon than in cases not operated upon and a chronic inflammatory sclerotic change develops.

Operations on the third type of prostate described generally give unsatisfactory re-

sults. These cases are of the same type that was formerly operated upon for persistent discharge and the results have been identical. With this conception therefore when definite signs exist as to the presence of suppuration about the deep structures of the perineum and when a definite operative procedure obtains for the relief of this condition with no danger of mortality it would seem that the indications are clear cut as to the method of dealing with it adequately. Proper drainage should be provided and this can be obtained most satisfactorily through perineal incision.

CONCLUSIONS

1 Acute suppuration in and about the seminal vesicles and prostate which does not quickly respond to palliative measures should be given perineal drainage.

2 Many cases of ischiorectal, perirectal and superior pelvicorectal abscesses and urinary extravasation have their origin in a perivesicular cellulitis and in the common treatment of the condition the original focus is usually entirely disregarded. In this respect they are analogous to peripelvic infiltration secondary to chronic tubal suppuration in the female and are equally a source of chronic infection.

3 Prostatectomy and vesiculotomy are most effective in the treatment of acute and chronic joint conditions and should be practiced more freely. Operation usually gives immediate relief from pain, prevents gross joint changes and induces hastened resolution of the inflammatory areas. Drainage should be maintained for at least 10 days and is of utmost importance in the after treatment.

4 Operation does not guard against recurrences in the rheumatic cases and sterility and functional disturbances are to be reckoned with. Sterility is probably coincident with the operation and not caused by it.

5 The periprostatic infection with infiltration of the ejaculatory ducts is largely contributory to the vesicular infection and free adequate drainage must be provided by liberal prostatic incisions.

6 In cases with remote or recent venereal etiology operation may be performed without undue risk and the mortality is nil.

CHANGES IN THE CHLORIDE METABOLISM IN ABDOMINAL LESIONS¹

By REFD POCKWOOD M D A D R S ANDERSON M D BALTIMORE
 F m t h D p t m f M J I S g y U t y f M a r y l d B i m

THE work of Brown Eusterman Hartman and Rowntree Haden and Orr Dixon McVicar and others has emphasized the importance of changes in the chloride metabolism in obstructions in the gastrointestinal tract and in similar allied conditions. It is not generally recognized however how frequently such conditions may occur and how proper treatment particularly by the administration of large doses of sodium chloride may often prove to be a life saving measure. For this reason therefore we are reporting a series of cases all of which were observed in a relatively small hospital in less than a year's time.

Every surgeon is familiar with the patient with an abdominal lesion who comes into the hospital in an extremely toxic condition and who is recognized immediately as a bad surgical risk. An analysis of the symptoms presented by these patients shows that they fall into two general groups: first, those due to the pathological lesion present and second, those due to the associated toxæmia. The death of the patient may be due to either the toxæmia to the original lesion or to both. This point of differentiation is an important one for with proper medical treatment the symptoms due to the toxæmia may frequently be relieved thus preventing the death of the patient from this cause or at all events may make him a much better risk for operative procedures which will relieve the underlying pathological condition.

The symptoms of the toxæmia for purposes of discussion may be grouped as follows:

DEHYDRATION AND ITS CONSEQUENCES

Dehydration seems to be primarily due to the decreased fluid intake and to the increased vomiting frequently seen in such patients. In addition to the dry inelastic skin, parched tongue and other general manifestations of dehydration we also are apt to find a high haemoglobin due to concentration of the blood

and an oliguria. In the later stages albumin casts and red blood corpuscles may also be found in the urine.

VOMITING

Vomiting is seen in many such patients and adds to the severity of the toxæmia due to the tremendous losses of water and chloride which may occur in the vomitus. A gastric dilatation is frequent and large quantities of fluid may be found in the stomach on aspiration even though actual vomiting is slight or absent. Vomiting however is not essential for the production of the syndrome since low chloride figures in the blood have been observed both experimentally and clinically in the absence of vomiting. Functional vomiting may even be severe enough to produce the syndrome in the absence of any organic lesion.

CIRCULATORY SYMPTOMS

The patients are commonly seen in a shock-like state with a weak, thready pulse and low blood pressure. The asthenia is often profound. The patients may become drowsy or semicomatose or even delirious, a symptom which is most probably due to circulatory disturbances in the brain. Such a condition is sometimes difficult to distinguish from ordinary surgical shock and the presence of the changes in the blood to be described later often is a very helpful point in the differentiation. In some cases a peculiar scarlet flush may be seen over the face apparently due to local vasodilatation.

NEUROMUSCULAR IRRITABILITY AND TETANY

When the carbon dioxide combining power in the blood reaches the vicinity of 100 volumes per cent, general fine muscular twitchings and various tetanic manifestations, even actual convulsions, may be observed. The level of carbon dioxide at which tetany develops is only approximate rather than absolute.

TABLE I —UNTREATED CASES WITH LOW BLOOD CHLORIDE

N l N b	D t	B or Cu			D gn j m k
		Chl d 75 3 5 mg	CO 50-7	N 5 15 mg	
		75	4	46	P f t t l t y h l l l th j t t D l 3
	9 8	75	74	34	Ch d m l t p t th b N m d d m t g D
3		8	76	36	Ch t f a l m p t w h t R
4	7	8	7	38	I d i p t h h a m h g p e t y O p t p t
5	8 8	7	6	33	App d t 8 5 f t p p e R t g s f t p m
6		7	8	5	G t e t t m y f m h d t p f t
7	5	7		3	Adm t t d 5 h l l t k f l t t h t p t R
8	3	65		43	St u l t e d g l h O t r y
9	9 8	6	7	34	C m f g l h l l t h l c t t m y 9 3 D t b l h a m h g o 5
			64		Op t d p o f p t t e d g t B l t h p t t f m j y b m t g f m R o p t d f 4 R
	5	65	64	4	R t t d f t f l b t f t R y
	9	63	63	36	A t l h w t h c u t y t R r y p y
3	8 7	63	6	36	T m f m b R y
4	3 7	64		3	A t t k f h h l y t t R y w t h t p e t
5	3 3	6	53	3	B l r y l r y m h m t g t t p
6	5	6		33	o 6 Ch l y t m 5 p l C o s f l l g R y t t m y
7	4	6	5	5	O p e d p f p t e d p D l s d p t 3
8	0-6	6		36	Acu Rec t t k f h l e c y t t y w t h t t
9	8 5	56	64		C r e l t b e c u l o s t b o p l y p l l i t t d m t g m f d t

TABLE I —CONTINUED

N m l N m b	D t	B C m			D g d m k
		Chlo- d 75 3 5 mg	CO 5 7 mg	N 5 35 mg	
	9	56	65	38	9 l p t m y l d j l 9-9 t p t t D j l
	4 7	56		9	Cl p h t l h y p t d D h k l m p
	4	55		60	G f t l p t t D d 6 h t l m t t t p
3	8 7	54		9	Γ t e d f t t t g f t h K l t m t l d l t
4	9 8	5	76	4	9 h t t m y M h f t g l t R m t k d
5	3	5	6	3	B l l t h m t g L l 3 7
6	3	5		43	3 9 h m p l k D d 4 6 f b h p e u m
7	9-7	45	46	57	B h l l p g D d
8	8 4	4	7	30	8 4 l p t m y f c u t p p t l t l f l p t D d 8 4
9	8 4	4	83	9	8 x m t g 8 7 l f f 4 t l d t t b l b t t
3	4 7	4	5	79	D h t g P t f j j l g D l 4 7 m l
3	4 4	35	7	59	4 5 l y r t f l p f t d g t D l 4 6 l f t t
3		34		35	H t m y f t d g l h R
33	7 9	33	47	69	7 4 t t t m y d d d g f t t p t l f j t p t t t D l 7
34	6	3		67	B h l f p g R y
35	8		65	4	O r t l h y f t g l l f m l h D l g q
36	7	60	91	5	F d y h t y f l t m t p t t t d t t l l t h y m p t m l t l y All

SUMMARY

N p t D t M	C e w t h h l l b o 6 m g p e m		C b l t h h l l p e 60 m g m	
	3	4	8	6

TABLE II—TREATED CASES WITH LOW BLOOD CHLORIDE

N m l N m b	D t	BLOOD CHEMISTRY			D g n o s i s	d m k
		Chlo- d 75 35 mg	CO ₂ 5-7 /	N P 5-35 mg		
	8 7 5 3	86 6	3	6	P r t u l test l b tru t f m d h e s n s A t r y 4 l t h b o u t R r y t h o u t	
					I t r m t t p y l b tru t f m t p e t l m l i g	
	7 5 3 3	7 38	3	68	F r p l c y D e d f m t h d h o c k	
3		60	58	5	S t g u l t e d R h t h r n w i t h p e f t u d p e t o D i r g e D e d s	
4	4 5 -7 60 -9 3	7 43 68 3 65 3	57 43 33	57 43 33	R p t e d p r d i x G e l p m i t u s B f p e t u d t t r e m t D u n g h l d t t r D u n g h l d t t r D r i g h l d t t r R e d a r y t e s a l b t r u t R l o r m y d h e s a n d C h l d t t m t t u n e d R r y	
5	5 0-8 3	8 66	45 3	45 3	V a c u o u r l f f l i n g g a s t r o p e r t u s A f t m t B e f t t A f t r t m t	
6	8-9 8 8 8 3 9-6	7 63 56 3 5 3 67 7	56 3 5 3 0 9	56 3 5 3 0 9	R p t u e d p p e d i x w i t h d u i l s e p r i t Q p e t e d 8-8 P o s t o p e l e u t f t r t C h l d t r t m e n t A f t t o s t m y f l e u C h l d t r t m t C h l d t r e a t m t R c o r r y	
7	8 6 8 7	3 66 3	66 3	3	G g r o p p e d m u l l e u P e r t u s R f o r p e t u A f t t m t R e c o v r y	
8		3 2	2	2	R p t u e d p p e d i x w i t h g l F e d j f r m l d r i n C h l d t t m t (i n f i t i C h l d t t m t t u r f f e n) C h l d t t m t t f f i c i t 4 7 d r a m a p e l b a s e s 5 d e d	
9	8-7 9-7 9-7	3 86 35 60 93 64	78 55 3	86 60 64	P t l t t n a l b s t r u t f m a d h e s B f t t m A f t b e m t g f t t r t A f t t e t u C o a l e s c e n t R e c o v e r e d f m b e t r u c t u b t d i e d f m p e r m	
	8- 8-3 8	8 6 55 68 67 73	6 68 73	44 3	C m p l t b e t r u b y t f m a O p e d 8- b e f t t m t A f t e a m C o l e s c t R e c o v r y	

TABLE II—CONTINUED

N m l N m b	D t	BLOOD C M I S T R			D i a g n o s i s	d m k
		Chl d 75 35 mg	CO ₂ 5-7 /	N P 5-35 mg		
	7 5 7 6 7 9 7 3	79 7 7 36 30 86 30 95	5 65 5 86 5 95	60 55 55 7 95	E d m u g p l e y p h a t t w i t h d l e u	
	3 9 4 4	7 300 7 53	39 9		C h l e c y t t m y P o s o p e t g t e c t a i s R r y f t t m t	
3	3 3 3 4	7 75 75 65	5 5 4		P o s t t e s t m y P o p e r t u m u t g d g l t P e c r y f t t m t	
4	-7 8 9 9 6 3	8 94 31 8 5 95	7 4 7 4		N e u t r a m t u n g f p e r a n c y A d m u t e d A 4 p l T e d b y s o r m b a b o t A l k l d e c e d A t t i l l p e s e t A p l N t R o v r y	
5	6 7 7 3 9 2 3 7 4 4 5 8	2 8 3 66 2 80 7 76 6 35	8 3 3 34 3 34 3 35		G h t w d d f b d m w h t e s t l f r f t L a p a r t m y d t C h l d t t m t D r a g f x t p e t e a l b R e d t f f h r n t e d i n t e s t u s t h g h a n c e D e d	
6	3 3 3 4 3 5 3 7	44 58 60 55 95 53 5 57	44 58 54 60 53 53 7		P m m p t t D i n g p o s t o r e t l e u C h l d t t u r t a r t e d T o u r n t l l e d b t r t d i e d 3 f b h m u a a n d m p y m u	

tion to this rule is in patients to whom sodium bicarbonate has been administered when an extremely high carbon dioxide combining power may be found in individuals who are ambulant and complaining of only the very mildest symptoms such as headache anorexia malaise etc

The aims of treatment in such patients are twofold The medical management attempts to relieve the toxæmia The indication for surgical treatment is to remove the primary condition The closest co-operation between physician and surgeon is essential at all time if the life of the patient is to be saved

The treatment for the toxæmia consists of four measures vigorously and consistently carried out

The administration of water by all possible routes and in practically unlimited quantity unless there are other contra indications. This measure is designed to relieve the dehydration to counteract the factor of shock, to promote diuresis and thus to aid excretion of water and nitrogen by the kidney. Only when the results have been achieved can the patient be said to have had sufficient fluid.

The administration of glucose. The nitrogen metabolism in a fasting patient is high due to the fact that he is burning large quantities of protein from his own tissues. Excretion of even moderate quantities of glucose spares the nitrogen metabolism considerably. By the use of protein sparing food the protein metabolism may be reduced to at least a third of the fasting metabolism. This is of particular importance since we have shown above the protein metabolism is much increased in these conditions. Concentrated glucose solution intravenously also have a very marked diuretic action which is of value in combating a condition with oliguria. Because of the frequent association of vomiting with the lesion it is only occasionally that enough glucose can be administered by mouth. Ten per cent glucose intravenously at least twice daily is commonly used but this can be readily increased to 5 per cent without danger. It is a rule in all intravenous work not to give more than a total volume of 500 cubic centimeters at one time. One thousand cubic centimeters can be given however if the injection is made at a very slow rate. Glucose can also be given by rectum in concentrations up to 25 per cent although the absorption is variable.

The administration of sodium chloride. Many surgeons state that they use sodium chloride in the treatment of all cases of intestinal obstruction but close inquiry usually discloses the fact that they are referring to normal (0.9 per cent) sodium chloride solution. The dose necessary for the proper treatment of such cases are relatively enormous. Haden and Orr suggest that 1 gram per kilo of sodium chloride be given as an initial dose in acute intestinal obstruction and then the subsequent dose regulated by the chloride content of the blood. They report that in one patient 90 gram of sodium chloride was given

during the first 36 hours after admission. Only 18 grams of this appeared in the urine and the blood chlorides did not rise above normal showing that the body tissues needed and utilized this enormous supply. To give the patient this much sodium chloride as isotonic saline would have required the absorption of 10 liters in 36 hours subcutaneously and by rectum. Subcutaneous and rectal infusions should not be neglected but in addition it is necessary to use other routes. For mild cases of toxemia the intravenous injection of 1 to 2 per cent sodium chloride and glucose can be used. In the severer cases 10 per cent sodium chloride is necessary. If an enterostomy has been performed sodium chloride can be placed directly in the bowel.

The only guide to the adequacy of the chloride dosage is the content of the blood in chloride. In the case of toxic patients this should be determined daily. If the figure for chloride is below normal it indicates that insufficient chloride has been administered during the preceding 24 hours.

The administration of chloride also causes a fall in the carbon dioxide combining power if this be elevated and the additional administration of hydrochloric acid or calcium or ammonium chloride does not appear to be necessary. In the case of tetany due to alkalosis this might be considered as an emergency measure however. The combination of glucose, water and salt also causes a restoration of non protein nitrogen to normal level.

4. Gastric lavage. Large quantities of fluid often accumulate in the stomach of such patients and this as well as the tendency to vomiting is often greatly improved by frequent gastric lavage if there is no contra indication from the surgical standpoint. This probably acts by tending to restore muscular tone in the gastro intestinal tract which is notoriously defective in such patients and will tend to relieve any tendency to gastromesenteric ileus if the latter be present.

The result of this form of treatment as shown in Table II as well as the results in some cases which were inadequately treated. Brief summaries of the patients are given below. It will be noted that the chloride in the patients in most cases are well below 60

milligrams and hence are in the group which Table I shows to have a high mortality.

In observing these patients clinically the correlation between the relief from the toxæmia and rise in blood chlorides is striking and one gains the impression that the blood chloride test forms a very reliable guide to the progress of the toxæmia. It must not be forgotten however that many of the symptoms may be caused by the abdominal condition or by other factors rather than by the toxæmia. It is difficult to describe on paper the striking clinical change which sometimes occurs in these patients after treatment has been begun.

CASE REPORTS (TABLE II)

CASE 1 A nurse entered the hospital with a partial intestinal obstruction probably due to old post operative adhesions. The urine showed large quantities of acetone throughout her entire stay in the hospital but in spite of this the findings in the blood were those of toxæmia with alkalosis. She recovered under medical management without operation and a repetition of the blood chemistry showed that the figures had returned to normal.

CASE 2 An elderly male entered the hospital with a history of intermittent pyloric obstruction and an abdominal mass. The chemical studies showed moderate signs of toxæmia. The patient's condition improved under gastric lavage. An exploratory operation revealed a retroperitoneal malignancy which was left undisturbed. On the day following the operation he went into a shock like state from which he eventually died. The question arose as to whether the condition was one of shock due to recurrence of his gastrointestinal toxæmia or simple postoperative surgical shock. Chemical studies showed that the latter was the case.

CASE 3 A white male aged 55 was admitted to the University Hospital January 23 1927 after an illness of 4 days duration. At operation a strangulated Richter's hernia was found on the left side. A portion of the gut which had become invaginated in the internal ring was perforated and a localized peritonitis had developed. The patient was in very bad condition. An enterotomy was performed and the abdomen drained. Previous to the operation he had been given 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose solution and also 800 cubic centimeters of isotonic sodium chloride solution subcutaneously. Following the operation he was given 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose twice daily during the first day and once the second day. The patient died the second day after operation. Except for the retention of non protein nitrogen probably indicating renal failure the blood at the time of his death was normal.

CASE 4 A white male aged 23 was admitted to the University Hospital January 4 1927 after an illness of 3 days duration which was diagnosed as ruptured appendix with peritonitis. At operation the appendix was found to be gangrenous and a general peritonitis had developed. The appendix was removed and three drains were inserted. Isotonic sodium chloride solution had been administered both by rectum and by subcutaneous injection as soon as the patient entered the hospital. Two days following the operation the patient developed a paralytic ileus with obstruction vomiting a large quantity of fecal material. Five hundred cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given intravenously twice a day the stomach was lavaged and a duodenal tube left in place. Enemas were given but were only slightly effectual. The blood picture returned to normal under this treatment and the toxæmia subsided.

On January 11 the patient became completely obstructed. A second operation was done and a complete obstruction of the small bowel was found. The obstruction was produced by the matting together of the small intestine by adhesions. The obstruction was released and an enterostomy was performed. This secondary obstruction was accompanied by a recurrence of toxæmia and a fall of the chlorides in the blood. The patient returned to the ward in very bad condition. Intravenous medication was again administered twice a day and the stomach was lavaged at intervals. Very profuse drainage was obtained through the enterostomy opening. This treatment was continued for nearly 4 days following the second operation and from this time on he made a very satisfactory recovery. The patient was discharged from the hospital on February 27 in satisfactory condition although there was still a slight discharge from the enterostomy opening.

CASE 5 A white male aged 37 was admitted to the University Hospital on October 5 1926 with a diagnosis of chronic duodenal ulcer with partial obstruction of the pylorus. The patient had been operated upon 3 years ago for perforated duodenal ulcer and had been well until several months previously when he began to have recurrence of his dyspepsia. A posterior gastro enterostomy was done on October 6 for a large indurated ulcer which almost completely obstructed the pylorus. Six days following the operation he began to vomit large quantities of greenish material. At this time it was thought that possibly an obstruction had taken place in the area of the distal loop but later it was decided that a vicious circle had developed. Intravenous medication was begun 500 cubic centimeters of 5 and 10 per cent glucose with salt being given twice a day for 3 days. The patient was allowed only small amounts of water by mouth. The duodenal tube was passed at different intervals. After the third day of intravenous medication the patient seemed to be in much better condition. During the entire course of this treatment the patient's skin was moist and his output was good. From this time he made

a very satisfactory recovery and was discharged October 9

CASE 6 A white female aged 30 years was admitted to the University Hospital on August 18 1926 with a diagnosis of acute appendicitis 48 hours duration. The patient was 4 months pregnant. At operation an acute gangrenous appendix was found with diffuse peritonitis. The appendix was removed and four drains were inserted and the patient improved slowly. On the third day following operation she developed a marked paralytic ileus and began to vomit profusely. Enemas were given and the stomach was washed out but this did not relieve her. On the 5th of the chemical change in the blood intra-venous medication was begun 50 per cent glucose and 5 per cent sodium chloride solution being used. During the first day 350 cubic centimeters were given in three times and 400 cubic centimeters of the same solution were given twice on the second day. Enemas and lavage were repeated as often as necessary. The enemas were not effective but at each lavage the effluent was removed in large quantities. On the sixth day of illness when medical treatment was done the patient received a large amount of gas and collapsed at operation. The patient seemed remarkably improved. Intravenous medication was continued 400 cubic centimeters of 50 per cent glucose and 5 per cent sodium chloride solution being given twice daily for 3 days. Lavage and enemas were continued. The patient had 100 cubic centimeters of 5 per cent sodium chloride solution put directly into the enterostomy tube on two occasions. Following this treatment the patient seemed much improved but aborted on the eleventh day after the first operation. From this time on he made a very satisfactory recovery and was discharged on September 19 cured.

CASE 7 A white male aged 35 was admitted to the University Hospital on August 16 with a ruptured appendix and peritonitis of 3 days duration. On admission the patient was very ill and had been omitting to eat for 2 days. On the basis of the chemical findings in the blood 500 cubic centimeters of 5 per cent sodium chloride and 50 per cent glucose were given intravenously before operation. At operation a ruptured appendix with diffuse peritonitis was found. The appendix was removed and the abdomen was drained. The patient was given 1000 cubic centimeters of the same solution intravenously in the first 12 hours after operation. The blood was taken for analysis the following day with the result shown. The patient made a satisfactory recovery and was discharged from the hospital on August 26.

CASE 8 A white male aged 16 was admitted to the University Hospital on April 7 1926 with a diagnosis of ruptured appendix and general peritonitis of 4 days duration. At operation the appendix

was removed and the abdomen drained. Five days after the operation the patient developed a paralytic ileus and began to vomit large quantities of brownish material. The stomach was washed out and enemas were given. No intravenous medication was given at this time but only isotonic saline. Sixteen days after operation he developed a pelvic abscess which was opened April 27. There was considerable hemorrhage from the abscess cavity and the patient was in a critical condition. At this time the patient was given the first intravenous injection of 10 per cent sodium chloride and 10 per cent glucose but he died on May 2. It will be noted that at no time was sufficient sodium chloride given to bring the blood chloride to normal hence the associated toxæmia was insufficiently treated.

CASE 9 A white woman aged 50 was admitted to the University Hospital on August 27 because of partial intestinal obstruction of 4 or 5 days duration. This was apparently due to adhesions from an operation for appendiceal abscess 3 years previously at which time the appendix was not removed but the abscess merely drained. On admission to the hospital the patient was in a state of profound shock with a rapid pulse markedly distended abdomen and fecal vomiting. On the basis of the chemical changes in the blood intravenous medication was commenced. During the first 2 days one liter of 5 per cent sodium chloride solution and 10 per cent glucose were given and 500 cubic centimeters were administered on the third and fourth days. Very little was given by mouth at this time but the stomach was washed out repeatedly and enemas were given. The patient's condition on the fifth day after admission did not improve but she still had partial obstruction. She was operated on September 1 and many adhesions were found to be present and the gut was firmly adherent to the old scar causing obstruction. The adhesions were released and the obstruction corrected. Four hundred cubic centimeters of the intravenous medication described above were given daily for 4 days. The stomach was washed out and enemas were given which were no more effective. She improved very much for the next few days but on the tenth day after operation she developed a fecal fistula her wound broke down and the fecal fistula drained for 4 or 5 days and then closed. She improved very rapidly for the next few days except for heart attacks. Three weeks from the day of operation she developed a bronchopneumonia and died a few days later although for a long time previously there had been no symptoms of obstruction or toxæmia and the blood was normal.

CASE 10 A colored male aged 12 years was admitted to the University Hospital on August 11 with symptoms of intestinal obstruction of 24 hours duration. The patient was markedly dehydrated the abdomen was greatly distended the pulse was rapid and the patient was in a state of shock. An enema was given but was not effective. In 1000 cubic centimeters of 5 per cent sodium chloride solution and 5 per cent glucose were given soon after

admission. A few hours later the patient was operated on. An internal hernia was found which consisted of a large portion of the small bowel passing through the foramen of Winslow into the lesser peritoneal cavity. The proximal loop was markedly distended and the distal loop collapsed. The hernia was reduced and the patient was returned to the ward in fair condition. Nothing was given by mouth and enemas were ordered as necessary. Three hundred and fifty cubic centimeters of intravenous solution were given twice daily for 3 days. On the tenth day after operation the patient developed a fecal fistula which closed spontaneously in 3 or 4 days. He was discharged from the hospital September 24 in good condition.

CASE 11. This patient entered the hospital with an acute epidemic encephalitis. It was characterized by medullary symptoms including an almost total paralysis of the vagus resulting in marked abdominal distention due to paralytic ileus. The development of the chemical signs of toxemia secondary to this ileus can be observed in the table. Chloride treatment was commenced and although he died from respiratory and renal failure the blood chlorides at the time of his death had been brought up to normal.

CASE 12. A white female aged 48 was admitted to the University Hospital March 24, 1917 with a diagnosis of cholecystitis of several months' duration. At operation a very much inflamed gall bladder was found but no stones. In addition to a cholecystectomy the appendix and a cystic ovary were removed. Three or four days following operation the patient developed a marked paralytic ileus with great distention and began to vomit large amounts of brownish material. A duodenal tube was passed and enemas were given. Four hundred and fifty cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given twice a day for 3 days and then 450 cubic centimeters of 2 per cent sodium chloride and 10 per cent glucose three times a day for 2 days. The patient's condition improved and she made a satisfactory recovery.

CASE 13. A white male aged 60 was admitted to the University Hospital February 14 because of hypertrophy of the prostate and increasing symptoms of obstruction of 7 months' duration. On entrance the patient was in very bad condition and seemed to be on the verge of uremia. He was given large amounts of fluid for 10 days and then a suprapubic cystostomy was done on February 23. The prostate was removed on March 8. Following this operation the patient was very sick and toxic and began vomiting. For 3 days the patient was given 900 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose intravenously. The urine output became much better the toxic symptoms subsided and his vomiting ceased. The patient made a very satisfactory recovery and was discharged from the hospital as cured on April 4.

CASE 14. This patient entered the hospital with vomiting of pregnancy. Because of the presence of large quantities of acetone in the urine she was

thought to be suffering from acidosis and was given 10 per cent sodium bicarbonate by rectum. The blood chemistry on the succeeding day however showed a marked alkalosis which had probably been aggravated by the alkali treatment. That this was not the only factor is shown by the persistence of the acetoneuria and alkalosis after the discontinuance of alkali therapy.

CASE 15. A colored male aged 25 was admitted to the University Hospital February 13 following a gunshot wound of the abdomen a few hours previously. The bullet had penetrated the abdomen near the midline just below the umbilicus. Immediate operation showed ten perforations in the small intestines and a great deal of blood in the peritoneal cavity. The perforations were closed and the abdomen was drained. The patient was in shock when he left the operating room. Two days later he became much distended began to complain of abdominal pain and vomited. The chemical findings in the blood at this time are shown in the table. A duodenal tube was passed the stomach was washed out an enema was given and 1000 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given daily. The patient's condition improved and he was started on small amounts of water by mouth. He later developed a huge extraperitoneal abscess in the right iliac region which was opened on February 23. At this time the bullet was located. The crest of the ilium had been fractured and there was a huge abscess present which later had broken into the peritoneal cavity. This was drained. The day following this operation the patient's abdominal wound broke down and his intestines came out on the abdominal wall. This was repaired immediately but the patient was in a very bad condition. A liter of intravenous solution was given daily for the next 2 days and a duodenal tube was passed siphoning off a large amount of brownish material. The patient's condition grew gradually worse and he died the following day February 5. A chemical analysis of the blood shortly before his death showed it to be normal.

CASE 16. A white male aged 60 was admitted to the University Hospital on March 1, 1927 with a diagnosis of generalized peritonitis of several days' duration. He had had bronchitis for several days previous to his abdominal symptoms. At operation a generalized peritonitis was found and a large amount of pus was removed from the abdomen. Much fibrin was present. Cultures were made which grew staphylococcus and pneumococcus. There was no real pathology to account for the generalized peritonitis therefore the operative diagnosis was a pneumococcus peritonitis. A few days following the operation a paralytic ileus developed and the patient began vomiting. Intravenous medication was begun 5 per cent sodium chloride and 10 per cent glucose being used twice daily for 3 days. The stomach was washed out and enemas were given. The patient's condition improved. The following day 2 per cent sodium chloride and 10 per cent glucose were given

after a lay for 2 days. The patient's condition seemed so much improved that further intravenous medication was stopped. Eleven days following operation he developed pneumonia and 7 or 8 days later an empyema from which were aspirated 700 cubic centimeter of foul smelling watery material containing bacillus coli. A few days later the chest was again aspirated and pus as with the first. Thoracotomy was not performed and the patient died 48 hours longer dying from a terminal bronchopneumonia.

SUMMARY

1. Fifty-two cases of conditions with a low blood chloride are reported. Most of these are associated with abdominal conditions. These occurred in less than a year's time in a relatively small hospital. This high frequency indicates that this form of toxemia is much more common than is generally realized and is probably being overlooked in many institutions.

2. A fall in the blood chlorides in such cases below 60 milligrams per 100 cubic centimeters is accompanied by a distinct rise in mortality if untreated.

3. Clinical indications for the ordering of the necessary blood chemical tests by the physician are given.

4. Proper treatment of the patient along metabolic lines in many cases lowers the mortality and makes the individual a better risk for operation.

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THE CHOKED LABYRINTH AND ITS IMPORTANCE FOR DIAGNOSIS AND INDICATIONS IN BRAIN TUMOR¹

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IF FROM the diagnostic standpoint one wishes to conceive fully a disease beyond the anatomical borders of the organ of hearing the symptom must be classified into the following group: (1) symptom as revealed by endoscopy together with disturbances of function of the ear; (2) mastoid symptom; (3) cerebral symptom; and (4) general symptom.

The examination of the patient must be adapted to such grouping. The diagnostic importance of the ear examination is characterized by the fact that two of these four groups concern the ear. We may say that our diagnostic and therapeutic access with intracranial otogenous diseases is due to this systematic arrangement of the examination and that on the basis of the complete consideration of such symptomatology the diagnosis follows in a natural sequence.

By degrees it has been found that a whole series of ear findings may be considered characteristic of certain intracranial changes. In the cerebral and general symptom in a case point to an otogenous complication the ear finding alone may help us to localize to a certain degree the complication in the cranial cavity. When otology became of importance in neurological surgery it became necessary not only to study exactly the finding of the ear but to broaden our knowledge beyond the domain proper of otology into neurology. However, the diagnostic importance of ear finding is recognized when one can localize intracranial disease by means of them in conjunction with the cerebral and general symptom. Thus, the phlebitis indicated by the sudden cessation of ear suppuration. Suppuration of the attic suggest an abscess of the temporal lobe; suppuration of the antrum with retention suggest a paranasal infection and hypotympanic suppuration especially with hypotympanic cholesteatoma suggest a bulbar phlebitis and a bulbar thrombosis. Postmastoid pain indicates a pericranial

abscess and labyrinthine suppuration suggests a cerebellar abscess. Of course we cannot diagnose such intracranial diseases by means of the ear finding alone but they give us a reliable indication to the proper diagnosis.

In all of the examples mentioned the affection of the ear indicates the primary disease and the intracranial complication will indicate the secondary disease viz. the intracranial symptom are subordinate to the ear symptom.

Notwithstanding the above condition it may be that the ear finding and the cerebral complex of symptom are co-ordinate to each other since we find the same symptom with abscess of the temporal lobe as with a gumma or with a tubercle of the temporal lobe or with a cerebral hemorrhage in the temporal lobe. In such cases the ear finding are suggestive of an abscess. The finding of a florid ear suppuration together with cerebral symptom which point to the temporal lobe will indicate an abscess of the temporal lobe rather than some other anatomical change. Also under such circumstances the ear finding will support us in answering the following questions:

1. Is there an otogenous intracranial suppuration or an anatomical change?

In what part of the intracranial cavity are the changes localized?

Quite different are the premises with cerebral neoplasm for there irrespective of the cases in which an acoustic nerve tumor begins to grow in the depth of the auditory canal the cerebral disease will represent the primary change and the affection of the ear will represent the secondary change. In such instances the ear disease is subordinate to the cerebral disease. It is otology to do service in the diagnosis of brain lesions and aid in determining surgical indication we must endeavor to find out with what frequency certain neoplasm of the brain are associated with characteristic changes in the ear so that no matter whether



Γ T m of th p t l l be \ t p r t d p
 Chok d l by th Amp ll up d l t l th
 th c te mp ll At phy f th mp ll es
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F T m f th p tall b \ t p t l po
 Ch k d l l y th E d te dt s d t th h
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clinical brain symptoms have been ascertained or not the ear findings will enable us (1) to decide whether or not there is a cerebral disease (2) to decide whether the changes are functional or organic and (3) to ascertain the seat of the cerebral affection.

The ear findings however can attain such high importance in the diagnosis of the brain neoplasms only if in the first place it is proved that the ear shows changes in a considerable percentage of brain neoplasms and second if it is proved that the changes of the ear are characteristic for cerebral neoplasms of certain localization. J. Fischer studied these questions by the clinical and anatomical examination of a large number of brain neoplasms in numerous instances he repeatedly and at regular intervals examined certain cases. We have the ear findings in a number of cases

before and after a brain operation. In some of these the neoplasm was exposed and removed surgically and in others we had to satisfy ourselves with a pressure relieving operation.

It would be wrong to assume that all aural changes belong to the syndrome of the choked ear although we cannot deny that a brain neoplasm of any localization may be the cause of a choked labyrinth. However the closer topographically the brain neoplasm is to the ear and more particularly so to the inner ear the more directly may the changes of the ear develop as the neoplasm itself may involve the eighth cranial nerve and the labyrinth or the pathologic anatomical changes in the neoplasm itself (hemorrhage, degeneration, cyst formation, proliferation of the connective tissue, etc.) may extend into the labyrinth. Under such circumstances it will be difficult even impossible to separate the consequences

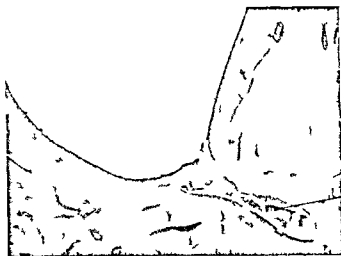


Fig. 3 Tumor of the upper region of the petrous part of the temporal bone. Not operated upon. Choked labyrinth. Blood and exudate in the cochlear aqueduct. *lc*

of obstruction from the other changes. However it is the object of this paper to try to prove the possible presence of a choked ear.

For such a purpose the most suitable case of cerebral neoplasm is the one the farthest from the ear. The method of discovering the choked ear by clinical examination must consist therefore in ascertaining the changes of the ear which occur with neoplasms found within the anterior and middle cranial fossae. Only with such experience may we undertake to learn the components of the choked ear in the presence of such affections as cerebellopontine angle and acoustic nerve tumors.

Before going into the discussion of this group I should like to give a short report on the anamnestic symptoms of the choked ear to be found during the examination of the ear and upon the necessary extent and course of such an examination.

What are the symptoms of the choked ear? In the history of the case we may learn that deafness has developed slowly, often with remissions at first to temporary normal hearing. Deafness usually shows however a distinct progression whereas acute deteriorations are seldom found. Such symptoms present a great contrast to the changes of the ear appearing with tumors of the acoustic nerve which are characterized by rapidly occurring permanent deafness. Subjective noises are common in almost all cases and in a majority of them a high sound is heard.

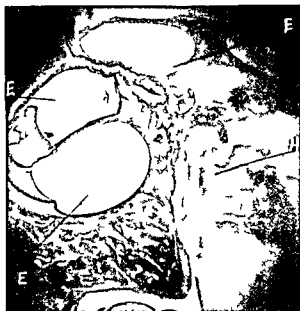
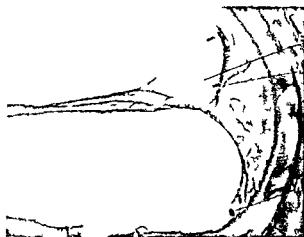


Fig. 4 Tumor of the middle fossa. Not operated upon. Choked labyrinth. Hemorrhage in the internal auditory meatus. *E* exudate in the scala. *eee* and in the cochlear canal. *Dc*

Examination shows a labyrinthine affection which cannot always be differentiated from other labyrinthine affections. Thus the upper limit of hearing is strongly diminished while the lower limit of hearing is not greatly diminished. There are also cases in which with comparatively little diminished acuteness of hearing the conduction of sound by the cranial bones is strongly reduced. Such peculiar findings may also be present with luetic labyrinthine affections and with injuries of the head. Habermann found reduced conduction of sound by cranial bones for low tones and Cradenigo reports a considerable increase of electric irritability of the cochlea, but Fischer was unable to confirm these findings.

The labyrinthine symptoms consist of spontaneous nystagmus, vertigo, reduced sense of equilibrium, changes of the labyrinthine reflex excitability and in addition thereto wrong pointing in the pointing test, abnormal and atypical falling reactions, disturbances of the eye muscles and disturbance of muscle tonus reactions.

We often meet with vertigo in the anamnesis of brain tumors of the anterior and middle cranial fossae. This however is usually of slight degree. The attack is not fully developed and the patient therefore cannot state



I 5 T m f th m d d l f N t p t l p
 Ch k d l l y th f hvp al am th l l

details because he does not notice them. He will often speak of an uncertain sense of vertigo of motor uncertainty numbness etc. In vertigo produced by turning in the majority of cases the apparent rotation is projected to the surroundings of the patient. It follows the direction of the quick component of the spontaneous nystagmus whereas the reaction movement of the patient follows the direction of the slow component. By looking in the direction of the quick component the degree of vertigo will be increased. A detailed description of the vertigo found with the choked ear would be a repetition of that given for vertigo in labyrinthine diseases.

We must know the details of labyrinthine vertigo thoroughly for if the patient has only rare attacks we will not be able to see them and note the objective phenomena. By means of experimentally produced vertigo otology has made us acquainted with the missing detail. In experimental vertigo we are able to observe all of the detail which characterize weak medium and strong labyrinthine vertigo. Then by comparing the symptoms that were found in experimental vertigo with those symptoms reported by the patient we will be able to say exactly whether the patient is suffering from a light or from a severe vertigo without having actually seen the patient in an attack.

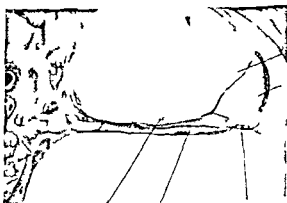
In every case of vertigo we must separate the patient's subjective and objective symp-

toms. In experimental vertigo the symptom must be divided into four groups: subjective and objective symptoms during and after attacks of vertigo. Two additional groups must be added in vertigo occurring as the result of a pathological process inasmuch as an aura is usually present. These include the subjective and objective symptoms of vertigo which occur during the aura. It is necessary therefore to group all of the anamnestic statements made by the patient about his vertigo within the six groups.

1. Subjective symptoms which occur during the aura before an attack: psychic and motor exhaustion loss of appetite sudden changes of increase or decrease in acuity of hearing and acute change of the subjective noise. Such noises in the ear may disappear before the attack of vertigo or if there were no such noise they may appear as a preliminary symptom of vertigo (more particularly so with vasomotor vertigo of the labyrinth) or finally such noise may be increased to an enormous degree (a howling and roaring (with arterio-sclerotic vertigo)).

Objective symptoms of the aura: paleness in other cases hectic redness of the cheeks hollow eye sockets slack deportment tired or staggering gait and a dizziness like of walking.

3. Subjective symptoms with the attack of vertigo: apparent rotation of the patient's surroundings or of his own body changed location of the objects of the surroundings or the floor (vertigo by touch) lateropulsion



I 6 Tum f th p t l l l N t p ted po
 Cl ked l l y th I lat th l l t phy
 f th hl N d f th f C t

(Brunner Babinski) and laterotractor (Brunner) disturbed sensibility and a disagreeable perception of smell and taste

4 Objective symptoms during the vertigo inability to walk in the direction of subjective rotation (the patient in the state of vertigo moves in the opposite direction to that of rotation) The patient will stand facing opposite to the direction of apparent rotation he will incline the axis of his body in opposition to the axis of rotation and he will look for a place to lie down endeavoring with all possible muscular exertion to get hold of solid objects in order to protect himself from injury by centrifugal action

5 Subjective symptoms after the attack of vertigo There are no symptoms after a slight attack of vertigo but after more severe or longer attacks there is numbness and a tired feeling However there is no disturbance of consciousness and in the case of labyrinthine vertigo (contrary to other types) the patient

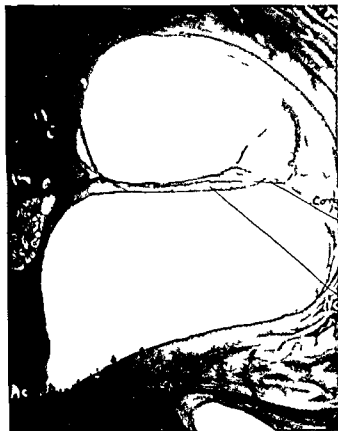


Fig. 7 Tumor of the middle fossa Not operated upon Choked labyrinth Passive hyperemia of the inner ear Atrophy of the cochlear nerve Ac and of the organ of Corti Cc exudate in the cochlear aqueduct Cc

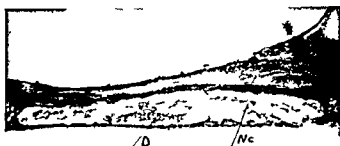


Fig. 8 Tumor of the parietal lobe Not operated upon Choked labyrinth Lamina spiralis ossea of the basal turn of the cochlea Atrophy of the cochlear nerve Nc Dapedisi of the blood vessels

himself is able to report all the details of the attack and its symptoms including the aura and duration of the attack After a more severe vertigo there is a sense of nausea and apparent rotation An apparent movement of the surroundings may still be observed to a slight degree after the attack although in the opposite direction

6 Objective symptoms after the attack of vertigo of a slight degree consist in more or less distinct disturbance of equilibrium and temporary disturbance of gait after violent attacks we note convulsions clonic spasms and vomiting In the case of labyrinthine vertigo vomiting always occurs at the end of the attack and is a symptom of severe vertigo Rotary vertigo during an attack may be accompanied by tactile vertigo However the latter may exist without the former Tactile vertigo has been thoroughly investigated by Brunner He distinguishes (1) tactile vertigo with delusions on the location of objects within the tactile area and (2) tactile vertigo with delusions as to location of the patient's own body In the latter group he also includes lateropulsion It is a striking fact that rotary vertigo is frequently a symptom in cases of frontal brain tumor However there are also cases of tumor of the middle cranial fossa with rotary vertigo

Spontaneous nystagmus is a typical symptom of brain tumors which produce the choked ear Intracranial pressure as a whole may cause spontaneous nystagmus centrally In such cases the spontaneous nystagmus only indicates the intracranial disease as such In connection however with the functional tests of the peripheral ear and the cerebellum the

spontaneous nystagmus may also be of great value in the localization of the intracranial tumor. For this purpose, however, all details of the spontaneous nystagmus must be considered. Only one who has the skill and experience to observe exactly the eight points of spontaneous nystagmus which I emphasized years ago will be able to utilize it as a diagnostic aid and a valuable symptom in the way of localization. The eight points that have to be established in considering spontaneous nystagmus are the following:

1. The association or dissociation of the spontaneous nystagmus viz. whether or not it is constant in regard to direction, amplitude, frequency, and intensity.

The direction—to the right, to the left, upward, and oblique.

2. Form of motion—rotating, straight, combined.

3. The velocity measured by the number of nystagmic strokes in the time unit (more than 100 strokes rapid, 40 to 100 strokes medium, under 40 strokes slow).

4. Amplitude—coarse, medium, and small, stroked.

5. Intensity—low, medium, and highest degree of intensity according to Alexander. In the slightest degree the spontaneous nystagmus is visible only when looking in the direction of the quick components; in the medium degree the nystagmus is also visible when looking straight ahead; in the highest degree of intensity the nystagmus remains visible when looking to the other side viz. toward the slow component; hence it is independent of the direction in which one looks.

6. The duration of the nystagmus. When spontaneous nystagmus is observed for a longer time it may either (a) remain the same, (b) disappear periodically, or (c) be more pronounced gradually, especially by repeatedly turning to the side.

7. The residence of the nystagmus, which also includes the motor nystagmus mentioned by Brunner.

If we consider the details of spontaneous nystagmus they may help to determine a fundamental localization of the pathology.

First of all we know that a violent spontaneous nystagmus may be caused only by acute

severe changes of the peripheral labyrinth (injuries and foudroyant suppuration) and that even under such circumstances the severity of the symptoms together with the spontaneous nystagmus has usually diminished by the end of the first week. The minimal type of spontaneous nystagmus on account of its duration alone will allow us to conclude that it is due to a central disease. An extended straight nystagmus indicates central changes near the nucleus of von Bechterew, while a straight and vertical nystagmus points to a disease within the reach of the posterior longitudinal bundle. Spontaneous nystagmus, however, as a clinical symptom will have full significance only in connection with the labyrinthine reflex excitability.

The proper examination of the labyrinthine reflex excitability consists of four different examinations: the rotation, caloric, mechanical, and galvanic excitability tests.

Examination in the rotary chair reveals the movability of the labyrinthine epithelium; the caloric examination reveals the moving and flowing capacity of the endolymph; the mechanical examination reveals the condition of the labyrinthine capsule; and the galvanic examination reveals the condition of the nerves of the peripheral labyrinth.

For years our efforts have been to go from the originally applied maximal excitability to the minimal excitability. This was fully attained by Kobrak's method of minimal excitability and by Kobrak's conception of the ease of production of the nystagmus. Thus we have attained an exact foundation for examining the labyrinthine overexcitability, a very important condition in the diagnosis of brain tumors.

When examining the labyrinth in the case of brain tumor, Fischer maintains that we can speak of a pathological reflex excitability only if there is also a spontaneous nystagmus at the same time. Thus he found the labyrinthine reflex excitability changed pathologically in 14 of 44 cases of cerebral tumor. Five other cases in which the examination of the external ear showed pathological changes but no spontaneous nystagmus he classified among the normal case in regard to labyrinthine reflex excitability.

As to the important details of his cases Fischer reports the following. In most of the cases we have to deal with an increased excitability inasmuch as both the latency is shortened and the nystagmus lengthened (7 of 9 cases). The overexcitability in almost all cases refers to both sides so that this symptom is of no importance in localization and can be considered only as the expression of increased intracranial pressure—a symptom of obstruction. If the increase of pressure in the skull cavity becomes intensive very rapidly or if such increased pressure is observed for some time the initial overexcitability of the labyrinthine reflex excitability may gradually diminish. This is analogous to the other reflexes which will increase as long as the condition of irritation persists whereas with paralysis they will diminish or disappear. In my material of 9 cases having a pathologically changed irritability I could observe only cases with irritability below the normal. The one case was a frontal lobe tumor which at the beginning produced an overexcitability of both labyrinths and only repeated otological investigations showed an excitability below the normal. The other case was an endothelioma of the dura which had compressed the greater part of the temporal lobe and which was accompanied by a proliferation of the tumor substance into the petrous bone. I could in this case establish clinically an excitability of the affected side below the normal and an overexcitability of the contralateral side. Serial sections made through the ear in this case did not show any changes in the nervous labyrinthus nor in the ganglion nor in the terminal places whereas the spaces of the middle ear were filled with tumor substance and the tympanic membrane was considerably thickened as a result of the tumor in filtration. In discussing the histological findings of the ear I stated that the tumor masses had rendered difficult the conduct of irritation and that this fact was the cause of the underexcitability and more particularly of the very much prolonged latent period.

Examination in the rotary chair will sometimes give valuable information about the choked ear. Reflex excitability may thus be maintained with no caloric excitability or

reflex excitability may be absent whereas caloric excitability is maintained.

In the presence of increased intracranial pressure the sensation after turning may be disturbed (Fischer). Eagleton under such circumstance found reduced excitability of the reflex within the sphere of the vertical semicircular canals. In neoplasms within the posterior cranial fossa the greatly increased intracranial pressure places the labyrinth entirely out of function. Especially with the circumscribed subdural or arachnoid accumulation of fluid upon the anterior surface of the cerebellum and the brainstem the reflex excitability upon rotation may be greatly diminished. In general we must be very careful in examining in the rotary chair patients who are suffering from a brain disease. Too vigorous turning may have serious consequences.

Spontaneous past pointing is known to be a characteristic symptom of neoplasms of the cerebellum. However Fischer found spontaneous past pointing in 4 of 44 cases of brain neoplasms of the anterior and middle cranial fossa and in 3 other cases found an atypical pointing reaction. He could not decide whether or not in these cases he had to deal with a distant lesion of the cerebellum. Nevertheless it is established that spontaneous past pointing does not come within the scope of choked labyrinth.

In only 2 cases of 44 Fischer found an atypical falling reaction. The tonus reaction of the arm according to which the sensation of gravity of both sides of the body is subjectively changed due to labyrinthine irritation is of no practical importance for the diagnostic examination of brain tumors.

When examining spontaneous nystagmus we must pay attention to any evident paralysis of the eye muscles as this often occurs with increased intracranial pressure more particularly on the rectus externus. In such cases the eye with the labyrinthine reflex will make stronger strokes in the direction of the paretic muscle than the unaffected eye thus simulating a dissociated nystagmus. In all cases in which paralysis of the eye muscles is caused by a lesion of the nucleus the eye upon the paralyzed side will lag behind in the caloric test and thus the stroke of the healthy eye

will be stronger. If on the other hand the disturbance of the eye muscles is due to a lesion in the peripheral portion of the nerve the nystagmus will be associated with irritation of the labyrinth.

Of further clinical importance is the paralysis of conjugate movements of the eyes. Fischer mentions 2 groups: the horizontal and the vertical. Paralysis of conjugate movements of the eyes to either side may be caused by a disturbance in the pons or in the cortex. The pathology in a case of paralysis of conjugate movements to either side due to a cortical lesion is always found at the base of the second frontal convolution in the gyrus angularis or about the fissura calcarina of the occipital lobe. In the case of a brain tumor which exhibits restriction of horizontal ocular movement we must first ascertain whether or not we have to deal with a paralysis of conjugate movement or with a paralysis of the muscle itself. With pontile paralysis no experimental nystagmus will be produced in cases in which the labyrinthine reflex arc is equally interrupted. When the latter is injured through a tumor the quick component will disappear whereas the slow component will persist.

Thus Barany could produce by rotation only the slow component of nystagmus in a patient with a paralysis of conjugate movement. In this case at the climax of the discrete movement of the eyes could not be produced in any other way than by vestibular irritation. Autopsy revealed a luetic infiltration of the corpora quadrigemina down to the pons. On the principle that spontaneous and reflexly produced nystagmus were lacking Barany assumed that the motor tract for eye movement was destroyed at the level of the visual center or between the latter and the nuclear region. On account of the irritability of the labyrinth it was out of the question to determine whether the nucleus was fully or almost fully intact whereas in paralysis of horizontal conjugate movements the distinction between cortical and pontile lesion may be decided. Such differential diagnosis does not come into consideration in paralysis of vertical conjugate movements because we do not know of any area in the cerebral cortex

which when destroyed will produce such a paralysis. Therefore we can conclude that this symptom is of great localizing value in tumors of the midbrain. In such cases there usually is a spontaneous nystagmus in the opposite direction hence with paralysis of conjugate movements of the eyes upward a downward vertical nystagmus and vice versa will be present.

If the tumor reaches further caudad for instance into the region of the nuclei of the eye muscles or into the fasciculus longitudinalis posterior then a combination of paralysis of the vertical and horizontal conjugate movements may be present. In such a case the quick component of the nystagmus will be missing when the labyrinth is being examined.

These are all of the ear symptoms which are observed in case of brain neoplasm and we must now inquire how much the individual finding change characteristically if we group the neoplasms according to their location such as those of the anterior posterior and middle cranial fossa. It goes without saying that the changes in the ear will be more developed typical and frequent the nearer the tumor is to the ear. However if we wish to study the choked ear we must exclude all cases in which the ear was attacked by the neoplasm directly either—as in the case with many eighth nerve neoplasms—by the growth of the tumor into the depth of the inner ear or—as in the case with tumor of the cerebellum and cerebellopontile angle—by the spreading of the neoplasm from the brain into the ear. Of course in such cases there are signs of congestion in the inner ear but only after having sufficiently established clinically and anatomically the picture of the choked ear are we able to differentiate the changes of the ear caused by obstruction from the other change of the ear due to direct extension of the neoplasm into the ear. In the first place we must investigate such changes of the ear as have been directly caused by the brain neoplasm and for such an investigation the most suitable case will be those in which the neoplasm is farthest from the inner auditory canal.

I wish to state the following with regard to change of the ear associated with neoplasm.

of the frontal lobes of the brain the midbrain and finally the cerebellum and the brainstem excluding the cases of direct extension of the neoplasm into the ear

In neoplasms of the anterior and middle cranial fossa Fischer found ear changes in 77 per cent of 44 cases in 60 per cent of all cases the cochlea was disturbed and in the majority of cases the disturbance was on either side In 9 cases the cochlear affection showed a distinct progression The labyrinth was disturbed in 60 per cent of the cases often with overexcitability and more rarely with under excitability In 4 cases there was violent spontaneous nystagmus without vertigo and in 4 cases there was spontaneous past pointing

I NEOPLASMS OF THE FRONTAL LOBES OF THE BRAIN

We frequently find slight difficulty of hearing similar to that of the inner ear with decrease of the upper tone limit and insulate and sometime varying acuteness of hearing Among the labyrinthine symptoms the disturbances of equilibrium stand out most prominently Fischer has collected the early literature on this subject (Wernicke Moeli and Nothnagel) and has found that Bruns was the first to point out the similarity of disturbances of equilibrium which appeared with tumors of the frontal lobe to that appearing with the ataxia due to diseases of the cerebellum Bruns assumed that the frontal lobe had the importance of a static locomotor organ which was in function superior to the cerebellum

The anatomicophysiological foundations of frontal ataxia have been repeatedly investigated Bruns Anton Zingerle and Kleist assumed that the frontal brain constitutes a center for the voluntary motions serving to maintain the equilibrium and that the impulses coming from this center are conducted to the cerebellum as a co-ordination center by way of the frontopontile cerebellar tracts According to Flechsig and others there exist fascicle of fibers extending from the frontal brain through the pons to the cerebellum Wernicke explains the frontal ataxia by a paralysis of the muscular apparatus of the trunk the centers of which are localized in

the frontal lobes He supports his assertion by the investigations of Munk and Meynert who attribute the strong development of the frontal brain in man and anthropoids to their upright position According to later investigations (Sherrington Vogt) such opinion has been refuted On the other hand many observers believe that ataxia present in frontal lobe tumors is caused by the intracranial pressure exerted on the cerebellum and the brainstem If such is the case homolateral disturbances of co-ordination should be proved with frontal ataxia in the same way as with cerebellar ataxia since we do not have to deal with bilateral extension of the neoplasms Ataxia is an essential symptom for the localization of tumor of the frontal lobe Fischer found tumors in 9 of 44 cases of cerebral disturbed equilibrium In 8 of these 9 cases there was a neoplasm of the frontal brain One patient had a tumor of the corpora quadrigemina If besides disturbances of equilibrium there are still other symptoms referable to the ear the differential diagnosis between a neoplasm of the frontal lobe and the cerebellum may become very difficult In the end we must always distinguish frontal ataxia from cerebellar ataxia Bilateral disturbance of co-ordination of the same degree will speak for frontal lobe ataxia Homolateral or at least bilateral disturbance of co-ordination not of the same degree speak for cerebellar ataxia Moreover normal acuteness of hearing normal labyrinthine excitability and no spontaneous nystagmus speak for frontal ataxia and against cerebellar ataxia In general impaired hearing and labyrinthine overexcitability point to a neoplasm of the posterior cranial fossa Fischer however recently saw 3 cases in which such symptoms were found with a frontal brain neoplasm Spontaneous past pointing which Karlefort says appears with cerebral neoplasms may be explained by the pressure exerted on the cerebellum It is clinically characterized by alternating spontaneous past pointing or by the appearance of a weaker pointing reaction with one or both extremities to the outside and a stronger reaction to the inside

In cerebral neoplasms there should be cerebral past pointing whereas other cerebellar

symptoms are missing. In 3 of his recent cases of frontal brain neoplasm Fischer did not find any cerebral past pointing and to him it is not surprising since he has already proved by his investigations that spontaneous past pointing may even be missing with cerebellar neoplasms. Warburg has demonstrated cerebellar ataxia as the summary of 3 groups of disturbances.

1. Disturbances of innervation (dysmetria hypermetria). Such disturbance is tested by means of the finger to nose test, finger to finger test, knee to heel test, by walking on a line and by walking with one leg crossed in front of the other.

2. Disturbed continuity of muscular contraction—astasia. These disturbances are characterized by insecurity, halting, staggering and even falling.

3. Disturbances in the order of motions—asynergia—characterized by the living behind of the trunk when the patient walks. The same thing is observed when the patient wishes to sit up from a lying position. He will then raise his legs unnecessarily high from the bed.

Normal acuteness of hearing or slight unilateral or bilateral or varying decrease of hearing speaks for an affection of the frontal brain. There is no spontaneous nystagmus or but a slight one with frontal brain neoplasms whereas a marked coarse and straight nystagmus of high intensity is found with affections of the posterior cranial fossa. With frontal lobe processes there is usually slight spontaneous inclination to fall without any characteristic localization while with diseases of the cerebellum there is always an inclination to fall in a certain direction. With affections of the vermis process and the middle lobe of the cerebellum the patient is inclined to fall backward or forward. Violent characteristic attacks of labyrinthine vertigo as rotary or tickle vertigo with spasms, vomiting, etc. from the onset of brain symptoms indicate an infection near the posterior cranial fossa whereas slight vertigo indicates an affection of the frontal brain. An early appearance of a choked disc with severe visual disturbances speaks for an affection in the posterior cranial fossa.

2 NEOPLASMS OF THE PARIETAL LOBE AND THE INTERNAL CAPSULE

Fischer was able to show quite clearly that in these cases the ear symptoms depend upon the other signs of obstruction. Among 10 parietal brain neoplasms he found the ear to be normal in 3 cases with no symptoms of obstruction. On the other hand he ascertained that particularly in the case of parietal brain neoplasms the ear symptoms appeared and grew clearly stronger as the intracranial pressure increased. Such ear symptoms were manifested by reduction in hearing ability, shortened conduction of sound by the cranial bone, reduced upper limit of sound and spontaneous nystagmus. With neoplasm of the parietal lobe there are sometime disturbances of the sense of touch and position. Disturbed hearing may be the consequence of obstruction or it may be a localized symptom with extension of the neoplasm to the auditory cortex of the temporal lobe. Deafness of cortical origin always involves both sides and is usually only slight. Unilateral deafness therefore speaks for symptoms of obstruction in the peripheral organ. If deafness signifies a localized symptom there are usually no symptoms of labyrinthine excitability or defect of the labyrinth.

3 NEOPLASMS OF THE OCCIPITAL LOBE

Here symptoms of labyrinthine excitability will appear more frequently than those of cochlear excitability of the neoplasm on the cerebellum. With no intracranial pressure the ear is found to be normal. In neoplasm of the occipital lobe changes in the eye are of course much more valuable as localizing aid than are changes in the ears. The labyrinthine reflex excitability does not help in the diagnosis since overexcitability and underexcitability of the labyrinth may appear either with general intracranial pressure or with disturbance in the neighborhood of the cerebellar fibers.

Eagleton asserts that increased intracranial pressure lead to a decreased excitability of the vertical semicircular canal. It may be entirely excluded with localization in the posterior cranial fossa. This symptom is certainly a general one and does not permit of

accurate localization According to Lagleton an accumulation of cerebrospinal fluid above the portion of the anterior surface on the cerebellum which is opposite to that of the posterior surface of the petrous portion of the temporal lobe produces the following symptoms diminished duration of the turning nystagmus exclusion of both vertical semicircular canals and spontaneous past pointing Later on the spontaneous past pointing will disappear By means of labyrinthine irritation however it will not be possible to produce past pointing in the direction opposite to that of the former spontaneous past pointing Accumulation of exudate in the arachnoid meshes above the cerebellum diminishes the duration of the rotary nystagmus by half Stenvers reports the forced holding of the head with brain tumors above and below the tentorium This he attributes to mechanical factors caused by disturbed outflow of the exudate If the tumor is above the tentorium the patient will bend his head backward in order to facilitate the outflow from the third into the fourth ventricle With tumors of the posterior cranial fossa the patient will hold his head forward in order to widen the communication between the fourth ventricle and the cisterna magna and also to widen the cisterna itself and to free the oblongata from pressure Such forced holding cannot be corrected by cerebral innervation

4. NEOPLASMS OF THE POSTERIOR FOSSA

A. TUMORS OF THE CEREBELLOPONTILE ANGLE

a Verus acusticus tumors Fischer found homolateral deafness and also in a considerable number of cases deafness of the inner ear of the opposite side of which the patient knew nothing subjectively In 44 per cent the labyrinth was not excitable on the side of the neoplasm Depending upon the position or size of the neoplasm both labyrinths may be unexcitable and both sides deaf In 1 case Fischer found inexcitability by rotation on the contralateral side and in another case overexcitability on the contralateral side with inexcitability on the homolateral side and a nystagmus for 6 minutes after the caloric test He found spontaneous nystagmus in 55

per cent of the acoustic tumors and spontaneous past pointing 8 times in 7 cases of which 3 showed spontaneous past pointing of the homolateral extremity toward the side of localization whereas the other extremity pointed correctly

b Tumors of the cerebellopontile angle excluding the acoustic nerve tumors The ear symptoms depend upon the seat of the neoplasm and in the majority of cases there is homolateral deafness and homolateral inexcitability and underexcitability

c Neoplasms of the pons and the medulla oblongata Fischer found in some cases deafness and inexcitability on the affected side However there are also cases of overexcitability with deafness or normal hearing

With hydrops of the recessus lateralis the spontaneous nystagmus may occur in attacks varying with the position of the head

B. NEOPLASMS OF THE CEREBELLUM

In about 50 per cent of the cases there is an affection of the inner ear and sometimes deafness Spontaneous past pointing is not often found Fischer found such past pointing in 2 out of 16 cases At the same time there may exist labyrinthine overexcitability and sometimes forced holding of the head In some cases there is no pointing reaction after experimental irritation of the labyrinth There may be atypical falling direction after the caloric test

COURSE AND PROGNOSIS

With early operation of the brain tumor many changes of the labyrinth may return to normal such as hyperemia and also formative changes without disturbance of function of the inner ear If however the choked labyrinth has persisted for some time no healing with *restitutio ad integrum* is to be expected The lost auditory cells cannot be restituted and the dilatations agglutinations etc represent permanent changes If during the process of the choked labyrinth permanent changes of the inner auditory canal and the aqueducts have developed then after the exclusion of the causative brain disease the affection of the inner ear may continue and develop into degenerative atrophy of the nerve

endings and the nerves of the labyrinth. We shall meet with the same unfavorable prognosis in all cases in which during obstruction endolymphatic hemorrhages and endolymphatic exudations have developed. In cases of decompression brain operations we must take into consideration the danger of hemorrhage within the region of the labyrinth especially in the endolymphatic portion and with the region of the internal auditory canal.

DIAGNOSIS OF THE CHOKED EAR

According to Fuchs in 90 per cent of the brain neoplasms the choked disc of the optic nerve could be found. Habermann describes the choked ear from the clinical viewpoint as increasingly poor hearing of deep sound through the bones of the head with comparatively good hearing otherwise. From the pathological anatomical standpoint there are 3 groups: (1) venous hyperæmia and lymphatic (2) inflammation and (3) degenerative atrophy. Fischer describes subjective noises during hearing, short need conduction of medium sound by the cranial bones diminished upper limit of sound, etc. He found that in cerebral neoplasms the ear symptoms appeared simultaneously with the changes of the fundus oculi. In two cases the ear symptom preceded those of the eye. Thus the ear findings are of great importance for the early diagnosis of the neoplasms of the anterior and middle cranial fossæ. Of still greater importance, however, are the ear findings in the diagnosis of neoplasms of the posterior cranial fossæ and of the eighth nerve.

It is much more difficult to judge the choked labyrinth by the clinical ear findings in connection with brain tumors. Fischer studied this question with the tumor material at the Berlin Clinic. He found that in quite a considerable percentage of cases there were positive ear findings, whereas the percentage was far behind that of the choked disc in cases of tumor of the anterior and middle cranial fossæ and even among the positive ear findings there must be diseases which are not caused by obstruction but by inflammation—neuritis nervi optici—or by the direct spreading of the tumor. To a great extent this is the case with changes of the ear due to tumors

of the posterior cranial fossa primarily at the angle of the cerebellum pons and the eighth nerve itself. Here the direct degenerative changes and the spreading of the neoplasm to the eighth nerve are the main factor. Hence we may assume that the farther the tumor is from the inner auditory canal the greater will be the labyrinthine changes due to the obstruction only.

Fischer considers both the ear changes and the choked disc to be important early diagnostic symptoms and of fundamental value in diagnosis. The ear findings may seldom be made use of in localization but still more frequently they are of value than is the choked disc of the eye which permits a localization only in exceptional cases. In order to establish the value of ear finding for the local diagnosis of brain neoplasms Fischer has divided all cases under his observation into 3 groups:

1. Cases in which the ear findings indicate the correct diagnosis.

2. Cases in which the ear findings are inclined to give incorrect localization.

3. Cases in which the ear findings are of no importance.

In 44 cases of cerebral neoplasms the ear findings together with other symptoms helped to correct the diagnosis of 1 case viz. in 47.5 per cent whereas in 5 cases viz. in 11 per cent the ear findings influenced the diagnosis in a wrong direction and in 18 cases viz. 41 per cent the ear findings were of no significance from a localizing diagnostic standpoint. In certain cases the otologist could only state whether or not the neoplasm was in the anterior or the middle cranial fossæ.

Among 7 cases of tumors of the acoustic nerve the ear findings helped correct the localization of the disease in 24 cases viz. about 90 per cent. In 3 cases the ear findings were misleading. In 16 cases of cerebellar neoplasm the ear findings helped make the correct diagnosis in 9 cases. Only in exceptional cases will it be the otologist's task to make the diagnosis of neoplasm whereas in most cases the ear findings hold either support or weaken the diagnosis placed by the neurologist.

From all these deliberations we arrive at the conclusion that the ear changes in neo-

plasms of the anterior and posterior cranial fossa are the result of obstruction some of which are capable of restitution and some of which will remain permanent. We must find out what constitutes these obstructive changes of the ear and how they come about. Unfortunately we cannot observe such change in the ear on the living patient while in cases of obstruction in the optic nerve we are able to make a rapid and unobjectionable examination. We must therefore examine histologically the ear of cases with fatal brain neoplasms and if possible we must take cases in which no brain operation was performed. Of particular value are all such cases in which the ear was exactly and repeatedly examined clinically. If we now summarize the anatomical ear findings of a greater number of such cases i.e. early cases and late cases we shall by degrees get a picture of all the anatomical changes which are possible with the choked ear. Here however we soon meet with a great obstacle since the early cases are not subject to autopsy whereas the late cases show only the maximum of ear changes. In order to ascertain the obstructive changes in the inner ear we may avail ourselves (a) of the well known histological changes in the choked eye (b) of experimental investigations and (c) of the anatomical ear findings of secondary labyrinthine affections of the different primary diseases besides the brain neoplasms in which because of the nature of the primary disease obstruction of the labyrinth is already rendered possible.

NORMAL ANATOMY

The correlation between the skull and the ear is such that all changes of the skull rapidly extend to the ear and on the other hand changes of the ear also will directly influence the skull cavity. Such ear changes are well known as intracranial otogenous diseases by their etiology occurrence and frequency. The changes in the skull causing secondary changes in the ear are however not so well known. Brunner would expect a difference in the changes and also in the reaction of the intracranial pressure upon the different anatomical structures of the optic nerve which is part of the central nervous system and of the acoustic

nerve which is a peripheral nerve. In opposition to this we must remember that especially with the labyrinthine nerve the glia (cortical) extends more to the periphery and on account of the channel like connections between the inner ear and the skull cavity the intracranial pressure will be conducted to the periphery of the labyrinth far better than it would be in the case of the eye.

Theoretical reflections on the occurrence of symptoms of choked labyrinth lead to different conclusion according to the initial view point. The comparatively close and direct connection between the labyrinth and the endocranium will make it likely that changes due to the intracranial pressure will be noticed quite readily in the labyrinth. We must consider that the inner auditory canal is considerably less filled by nerves which go through this canal than is the foramen opticum through which the nervus opticus passes. Especially in the fundus of the inner auditory canal within the reach of the ramified octavus we meet with wide fissures filled with cerebrospinal fluid which directly conduct the changes of pressure. The aqueductus cochlear connects the scala tympani of the cochlea directly with the endodural space.

If we wish to prove the possibility of a choked ear we must discuss a series of questions in different ways. The most important of these are the following:

- 1 What theoretical premises offer to the normal anatomy the casual and the regular occurrence of obstructions in the labyrinth?
- 2 What conclusion may be derived from the physiology of the ear in regard to obstruction?
- 3 What pathologico-anatomical findings offer an illustration for what we call a choked ear?
- 4 What clinical facts speak for the choked ear? It is to be understood that here we shall admit only such findings as have actually typical and frequent details.

THE NORMAL ANATOMICAL HYPOTHESIS FOR THE PRODUCTION OF THE CHOKED EAR

The labyrinth is directly connected with the skull by three channels two of which viz. the inner auditory canal and the aqueduct of

the cochlea end intradurally whereas the third one i.e. the aquæductus vestibuli ends extradurally. The inner auditory canal as far as it is not filled by the nervus acustico facialis conducts the lymph stream which course in and around this nerve through the little channels which run between the labyrinth and the inner auditory canal to the periphery of the inner ear. The aquæductus cochleæ ends perilymphatically and the ductus endolymphaticus terminates endolymphatically. We thus see that the preformed normal channels which represent the connection between the skull cavity and the ear terminate both centrally and peripherally. Another question is that of permeability. Normally there remains enough of a fissure around the nervus acusticus in the inner auditory canal which is filled with cerebrospinal fluid and which ends however in the depth of the inner auditory canal. Its continuation toward the periphery does not consist of anything else but the sum of the microscopical lymph spaces which run along the nerve branches into the inner ear.

We must not however neglect the difference namely that the increased intracranial pressure and the obstruction have a more direct and stronger influence on the optic than on the acoustic nerve.

According to Karlefors the function of the aquæductus cochleæ consists in the exchange of fluid between the brain space and the labyrinth. With adults in general it does not appear to let the fluid through quite so easily. The question may arise whether the stream flows from the labyrinth to the meningeal spaces or in the opposite direction. Karlefors assumes that the fluid in the aquæductus cochleæ runs from the meningeal spaces into the inner ear.

According to such an hypothesis the channel would be the same as the pachionian granulations and the nerve sheaths would be a drainage for the subarachnoid space and thus would also provide the perilymphatic space with fluid. According to Fischer we may consider the anatomical change of the ear in the same way as we do those of the eye in cases of increased intracranial pressure.

I cannot go into the theories of intracranial pressure in detail. Three groups of change

have been considered which are the cause of intracranial pressure symptoms and which should also prove the cause of choked ear: (a) the increased fluid pressure (b) disturbed circulation and (c) cerebral compression.

Different causes have been assumed for the choked disc and three different theories have been developed: the mechanical theory, the theory of inflammation and the neurotrophic theory. For the etiology of the choked ear we must moreover consider venous obstruction and compression of sinuses in the skull and the lability of the blood vascularization of the inner ear in which case—as Brunner supposes—previous vasomotor disturbance will create a locus minoris resistentie in the membranous labyrinth and in consequence whereof obstruction will develop more easily.

Embolism of the arteria auditiva interna may cause a neuritis nervi octavi. Any disturbance in the circulation of blood in the labyrinth must cause a rapid change of pressure there since the capillaries here not only serve to nourish the tissue but the endolymph secretion takes place in the stria vascularis and the slightest disturbance in the latter must soon be noticeable in the labyrinth. This takes place more rapidly as the membranous labyrinth is covered by a rigid osseous tissue in which the area change of pressure may be compensated only by the changed position of the stapes and the membrane of the fenestra rotunda. Labyrinthine hemorrhages may be considered as consequence of increased intracranial pressure as far as we have to deal with extensive and endolymphatic hemorrhage (Moos 1894, Panse 1906).

Sometimes the tumor formation within the reach of the cerebellopontile angle will lead to a widening of the inner auditory canal (also when the neoplasm itself had not been in the inner auditory canal) to a widening of the blood vessel in the inner auditory canal by obstruction analogous to the widening of the cerebellar and pontile vessels with such tumors as have been recently described by Nishikawa and to changes as with the choked disc of the eye. The walls of the widened vessels will often degenerate and with acute decompression may crack and thus cause hemorrhages in the inner auditory canal.

According to Hasse the overflow of the perilymph of the inner ear in the majority of cases of adults will take place in the inner auditory canal and only in a few cases in the aqueductus cochleæ. The permeability of the aqueductus cochleæ of the normal has been found only in children in whom it is empty and short whereas in adults it is long and narrow. Often in normal cases we shall find it narrowed and impermeable by connective tissue walls. Karlefors supposes the exchange of fluid between the endocranium and labyrinth to be in the aqueductus cochleæ although the latter in general is not easily permeable with adults.

The widening of the aqueductus cochleæ in a case of hydrocephalus (Häbermann Alexander) may be considered rather as an inhibited development than the consequence of increased pressure. While it is true that the aqueductus vestibuli and the ductus endolymphaticus enclosed in the former terminate extradurally yet we must consider that the endolymphatic sac which contains the endolymph and is embedded in the dura is situated on the posterior surface of the petrous bone and thus with intracranial increase of pressure the contents of the sac must be pushed forward against the sacculus vestibuli. The aqueductus vestibuli conducts the ductus endolymphaticus and the space between the latter and the osseous wall is filled by connective tissue. However there are distinct and very fine accompanying lymph vessels which extend to the outside as far as the saccus endolymphaticus.

Finally we must say that the normal anatomical premises offered by the three channels mentioned are not alone sufficient to expect typical appearance and typical extension of changes.

In cases of pathological changes in the skull cavity in the ear and more particularly in intracranial pressure we shall however get a different impression if we consider the supply of blood vessels of the inner ear. Here the connection is established by the thin arteria auditiva interna which takes its course from the circle of Willis which is about 4 centimeters long has no branch and which resolves into terminal arteries. Already from the normal anatomical structure it may be

expected that even slightly disturbed circulation in the skull cavity must rapidly influence the supply of blood to the labyrinth both in regard to functional disturbances and organic changes. We must bear in mind that the arteria auditiva interna works like a feeler lever on the pressure and the disturbances of circulation of the skull and that its movements as they are otherwise registered on the kymograph are not expressed by a symptom complex of the inner ear.

Wittmarck injected india ink into the subarachnoid space of a living cat and obtained the following result. Part of the substances injected into the subarachnoid space within a short time spread all over the subarachnoid space as a result of the osmotic differences. At the same time they get to the tissues of the subarachnoid space and its communications with the neighboring lymph tracts which mainly run along the tissue of the nerves. The aqueductus cochleæ also belongs to such communications so that these substances may enter through the former into the perilymphatic labyrinth space (Fischer).

Quincke by experiments on a dog found a direct connection between the subarachnoid space and the scala tympani.

As to the rest the results of experimental investigation are not unequivocal. Brunner by X-ray experiments on young dogs produced an acute hydrocephalus internus which was followed by a considerable acute intracranial pressure. However he could not observe any clinical ear symptoms. The inner ear of a cat treated in the same way was normal from the histological standpoint. On the other hand Szasz experimentally succeeded in producing a vasomotor nystagmus with amyl nitrite. It is beyond any doubt that the intracranial excessive pressure leads to an increased pressure in the labyrinth whereas the regular appearance and the duration of changes still remain questionable.

It has not as yet been determined experimentally what the mechanical changes in the membranous labyrinth are which result from the intracranial increase of pressure. However the ear findings with meningitis point to the fact that depression of Reissner's membrane (Steinbrügge, Gomperz, Moos and

others) cannot be explained by the foregoing and must be explained rather as an artifact. Quire considers depression of the membrana vestibularis with acusticus tumors to be the consequence of perilymphatic excessive pressure due to intracranial increase of pressure; the latter besides may cause a vasomotor irritation of the labyrinth.

Of considerable importance is the disturbed lymph secretion of the inner ear which condition has been deduced from the histological picture by Rejto, Wittmaack and Zange. Wittmaack believes that hydrops of the inner ear results from a hypersecretion of the endolymphs in the stria vascularis. This assumption however is rejected by Brunner, Nagel and Cimplinger found serous exudate without any symptoms in the case of choked labyrinth. Labyrinthine hemorrhages following decompression operations on the skull have not as yet been observed.

The individual portions of the membranous labyrinth do not offer the same premises for reaction due to obstruction. The plan of the perilymphatic tissue leads us to expect that the membranous cochlea and the sacculus will strongly and rapidly react to changes of pressure whereas the semicircular canals and the utriculus are more protected against pressure by perilymphatic septa (Burlett and Koster and Alexander). This discrepancy has been fully noted with regard to increased pressure coming from the middle ear and it illustrates the fundamental difference between the physiological action of the cochlea and the labyrinth. However pathological cases also confirm our viewpoint since ectasies as a sequence of intracranial pressure changes appear early and are frequently found within the vicinity of the pars inferior whereas they are very seldom seen in the pars superior and then only on the utriculus and not on the ampullæ and the semicircular canals.

Choked ectasia may be followed by other changes such as venous hyperemia and lymph stasis and inflammatory and finally degenerative processes with atrophy (Habermann) very possibly be combined with them from the very beginning.

The sensory cells in the cochlea as regards nutrition apparently depend entirely upon the

stria vascularis as the arteria auditiva interna remains intact. Thus Quire observed that the sensory cells of the labyrinth were intact in a case of acusticus tumor in spite of complete atrophy of the nerve stem.

In what way may the peripheral inner ear change on such an irritation? There may occur temporary and permanent change. According to their localization change may be distinguished as follows: (1) in the nerve (2) in the nerve endings (3) in the walls of the membranous inner ear (4) in the perilymph and endolymph (5) in the perilymphatic tissue and the perilymphatic septa (6) in the labyrinthine capsule (7) in the labyrinthine windows and their obturating portions.

In general the labyrinth is more resistant to injuries than the cochlea as regards a to whether they come from the periphery or from the skull cavity. Such a clinical experience is justified by two facts:

1. The resistance of a sense organ increases with the phylogenetic age. In the inner ear of man two apparatuses of very different phylogenetic age are united anatomically. The labyrinth goes through the entire series of animals down to the world of plants. In fact it is the primary sense organ. The cochlea on the other hand is an organ of hearing viz a sensory apparatus excitable by vibration coming from the exterior. It is first found in amphibians. The cochlear form viz the form of a round tube is shown rudimentarily in birds while the coil like cochlea is only found in mammals.

If we examine the size of the cell elements of which the nervous portions of the inner ear are composed we find that the sensory cell in the labyrinth are larger than those in the cochlea and that the cochlearis and the ganglion spirals are composed of very thin nerve fibers and very small ganglion cells. The nervus facialis shows the thickest nerve fiber and the largest ganglion cell all the way through whereas the labyrinthine nerve and its peripheral ganglia stand between the cochlearis and the facialis as to size.

Fischer himself has histologically examined 5 cases of tumors of the anterior and middle cranial fossæ which have not been operated on and his findings in the inner ear are as follows:

- (1) exudative changes (2) passive hyperæmia
- (3) hæmorrhages (4) changes in the blood vessels of the inner ear (5) circumscribed obstruction (6) cellular infiltration and diapedesis (7) increase of the labyrinthine pigmentation (8) agglutination and adhesions in the region of the membranous labyrinth (9) formative changes of the membranous labyrinth (10) degenerative atrophies of the nerve ganglion apparatus and the nerve endings and (11) osseous degenerations

In the cases of choked ear in which the tumors of the anterior and middle cranial fossæ respectively were not operated on Fischer found a homogeneous faintly colored exudate with cellular contents. At times he found a fibriform exudate on the base of the Corti tunnel which I too have observed with chloroma of the cochlea. The quantity of exudate varies from the most minute circumscribed exudate in the scala and the vestibule (auricle) to a large pronounced exudate of clots in the perilymphatic and endolymphatic spaces with accumulation of exudate along the nerve sheaths in the tractus spiralis foraminosus in the medullary spaces in Havers resorption spaces of the cochlear capsule and in the ligamentum spirale.

Hyperæmia is almost as frequent. We must however consider that an absolute unobjectionable proof of hyperæmia is very difficult. We find it in the cochlea in the form of a strong filling of the blood vessels in the medullary wall of the scala or of the promontory vein of the uricle and of the lamina spiralis ossæ. Also in the vessels of the stria vascularis there is frequently found a maximal filling of the strongly widened vessels which then project into the endolymphatic lumen like a ledge. There were similar findings in a case of luetic labyrinthine affection with individually acquired syphilis.

Fischer also refers to the constant occurrence of extravasation of blood in the labyrinth which may vary from a microscopic amount to that of considerable size. There often occurs a fresh hæmorrhage next to an old one. It is a question whether the increased pigmentation in the labyrinth which Habermann and myself have ascertained in cases of cerebral tumors and which I have also ob-

served with syphilis of the labyrinth is associated with the hæmorrhages. A considerable portion of increased pigmentation represents the increase of the normal perilymphatic labyrinthine pigment which does not come from the blood. Only in cases of luetic labyrinthine affection have I seen extensive pigment layers. Fischer has seen very small hæmorrhages between the layers of the lamina spiralis in the ductus endolymphaticus and in the sacculus. I myself saw such hæmorrhages in the ductus endolymphaticus and in the scala more particularly in the scala tympani and in the aqueductus cochlear. There may be extensive hæmorrhages in the inner auditory canal and in the scala septæ (Brunner Fischer).

Fischer refers to the histological symptoms of obstruction of the blood vessels in the inner auditory canal. The vessels are very much widened and around them is seen an abundance of blue or red stratified corpuscles and often a hyaline degeneration and a homogeneous exudate in the vessel.

As direct symptoms of obstruction beside venous hyperæmia of the labyrinth we must still consider the following: homogeneous exudate in the lymph spaces of the cochlear axis, the serous transudate in the ligamentum spirale and the œdema. In older cases a considerable connective tissue like thickening of the dural lining of the inner auditory canal may occur.

The most important formative change is represented by the ectasia of the entire pars inferior or part of the same—the cochlear sacculus of the ductus reuniens the ductus and the sacculus endolymphaticus. Some years ago I discussed the causes which prevent an ectasia within the reach of the pars superior viz the utriculus the ampulla and the semi-circular canals. In such cases we observe only diminutions in size of the lumina and this but rarely.

Decompression operations on the brain and skull cavity may cause traumatic hæmorrhages in the ear region and we can therefore consider such hæmorrhages as part of the symptoms of a choked ear only in cases that have not been operated upon. Degenerative atrophy involves the peripheral ganglia and the nerve endings. The sensory cells will remain more or less degenerated. The greater

part of the bone remains intact. The only change that can be ascertained at all consists in the destruction of bone in the form of widened inner auditory canal with a circumscribed atrophy and a formation of lacunæ.

When specifying the anatomical findings of a choked ear with distant brain tumors we must also consider cases of cerebellar and acoustic nerve tumors. This group has already aroused the interest of the investigators and we shall therefore have more complete anatomical ear findings. Fischer has compiled from the literature the anatomical ear findings with brain pressure.

Based on histological investigation of seven temporal bone Habermann (1917) groups the changes in the labyrinth as follows:

1. Change of the nature of a venous hyperemia and obstruction of the lymph vessels smaller and more considerable fresh and older hemorrhage in the inner auditory canal and the labyrinth abundance of pigmentation destruction of Deiters' membrane and the macula wall by excessive pressure of the perilymphs and endolymphs.

2. Change of inflammatory nature. Inflammation of the perosteum in the inner auditory canal infiltration of the cells between the nerve bundle proliferation of the connective tissue etc.

3. Degenerative and atrophic changes. Degeneration and atrophy of the nerve fibers and the ganglion cells of the nerve endings atrophy of the bone etc.

Fischer divides the ear changes into three groups:

1. Extension of disturbed circulation (transudation exudation cellular infiltration hyperemia anemia hemorrhage and pigmentation).

2. Irritative changes (ectasia narrowing collapse and obliteration).

Atrophic and degenerative changes.

Zinn (1905) in a case of a tumor of the cerebellopontile angle found degenerative atrophy of the peripheral cochlear nerve. With neoplasia of the connective tissue he found infiltrations of the round cells in the canals parallel to the cochlear vascular engorgement and extravasation of blood in all portions of the inner ear. He attributes the latter to

compression of the vena auditiva interna in the inner auditory canal.

Lange (1913) found in 4 cases of acoustic nerve tumor besides slight degenerative changes hyperemia extravasation and transudation of blood in the inner ear and exudate in the perilymphatic spaces which could be followed through the aqueductus cochleæ into the skull cavity. Pigmentation was also noted. Lange considers all changes as direct or indirect sequences of an increase of intra-cranial pressure.

Alexander (1907) examined a pituitary tumor which proliferated into almost all of the cranial nerves and caused an atrophy of both optic nerves. He found a hydropic degeneration of the perilymphatic tissue of the pars inferior degenerative atrophy of the sensory epithelium of all the labyrinthine nerve endings as well as a localized degenerative atrophy of the papilla basilaris cochleæ. In another case (neurofibroma of the acoustic) he observed fibrin reticulum in the perilymphatic space small cell infiltration in the connective tissue pad in the ligamentum spirale and a degenerative atrophy of Corti's canal.

Steiner (1923) referred the ear changes which he found in two cases of multiple neurofibromatosis partly to disturbed secretion as was described some time ago by Wittmaack (labyrinth hydrops).

Gruenberg and Manasse (1904) in cases of acoustic nerve tumor found degenerative changes and vascular alterations which they designated as choked hydrops in the inner ear.

Brunner examined a case of glioma of the left cerebellar hemisphere with secondary involution of the nervus acusticus. In spite of enormous atrophy of the nervus cochlear and the labyrinth he found the ganglion the nerve branches and the end organs of the internal ear in good condition. Moreover he saw vascular changes extensive hemorrhage in the inner ear and slight exudation. In his opinion the hemorrhage are result of an extensive variation of pressure.

With regard to the finding themselves I refer to the choked ectasia of the pars inferior with Paget's disease (Brunner Fischer) and with tumors of the inner ear (hypernephroma—Benesi) of the inner auditory canal.

with cretinism with hydrocephalus and finally also in many cases of turricephalia. The localized pressure changes or the conduct of excessive intracranial pressure upon the inner ear constitute the chief causes of such change.

Fischer points to the old view of Moos who thinks it is possible that the cranial pressure increased by a brain tumor is transmitted to the inner ear. However he is of the opinion that a compensation may be brought about rapidly by the flowing off of the cerebrospinal fluid into the vertebral canal and by lymph through the foramen cœcum jugulare and occipitale magnum (Merkel).

Besides atrophy of the nervus opticus Boettcher found atrophy in the nervous apparatus of the cochleæ and the sensory cells of Corti's organ. Moreover he found widening, winding and abundance of pigmentation. Moos supposes that similar to the hydrops of the optic sheath with larger tumors there might also be a hydrops of the acoustic sheath. In a later work he arrives at the conclusion that the communication of skull pressure increase by a brain tumor to the inner ear might be possible but that the compensation of pressure is favored by the flowing off of the fluid into the vertebral canal and of the lymph through the foramen cœcum jugulare and occipitale magnum. This may explain why with brain tumors the choked disc is found more frequently than is disturbed hearing.

As to the rest the findings vary a great deal. Thus Winkelbauer and Brunner among 7 cases of frontal brain abscess found 4 cases of disturbances in the region of the labyrinth and in not a single case any disturbance of hearing. Brunner after an experimental trauma of the skull found exudate, excretion of fibrin and transudate in the inner ear in pathological cases of trauma; he found bleeding and blood pigment in the labyrinth as well as ectasia of the ductus cochlearis of the second turn of the cochlea and the gyrus semitertius of the cochlea. Changed condition, concussion of the brain may be partly explained by vasomotor disturbances. Brunner from the clinical viewpoint found the nervus acusticus affected in 43 per cent of the cases of concussion of the brain.

The choked disc will always enjoy an indisputable standard as a diagnostic means; it may be ascertained by just one simple investigation. For the purpose of examining the labyrinth we make use of the labyrinthine reflexes, whereas with the cochlea we depend upon the reactions of the examined patient, viz. upon what he answers to our questions during investigation and we are thus exposed to mistakes and deception. Until further indications for the diagnosis of a choked ear are known we cannot dispense with repeated investigations at certain intervals for it is exactly the variety or the slow progress of the symptoms which allows us to determine with any certainty the diagnosis of a choked ear.

Fischer has already emphasized the fact that the findings of the inner ear may vary with brain tumors and we must comply with his conclusions that by systematic and repeated investigation the number of positive findings will rise.

We may diagnose symptomatic labyrinthine affections since the spontaneous nystagmus and the examination of the reflex excitability will reveal to us exactly the condition of the labyrinth. This method however fails in the case of the cochlea. If the patient in question does not complain of poor hearing only occasionally are we able to diagnose a symptomless affection of the cochlea because of the modern means for acoustic examination.

On this occasion I refer to the shortened conduction of sound by the cranial bones in a normal ear after skull injuries. Such findings however do not offer great reliability as the patient soon becomes tired. The same holds good for testing high and low sounds for on account of the vague results we have to repeat such tests and the patient becomes tired and inattentive. We are thus liable to be deceived by positive results. Progress may be expected only when an improvement has been made in our diagnostic methods.

In the foregoing I have said that the free and unequivocal cases of choked ear involve the pars inferior but not the pars superior. At the present time a clinical diagnosis of these combined affections of the sacculus and cochlea will be impossible and the diagnosis of disturbed function of the sacculus is still

rather distant. Today we shall only in exceptional cases be able to differentiate clinically the disease of the vestibular portion of the cochlea from that of the semicircular canal and for the moment we have not at our disposal any standard for recognizing disturbed acicular function in pathological cases. We may be able to diagnose the choked ear only by an improved functional test in the region of the cochlea by making use of the acoustic reflexes and by improving the clinical diagnosis of the diseases of the vestibular portion of the cochlea. We are still far from the minuteness of examination and diagnosis of the labyrinth which is possible with that of the fundus oculi. When we see how exactly the ophthalmologist can prove affections of the vitreous of the eyeball and a certain their degree we have to admit the lack of perfection in the diagnosis of labyrinthine disturbance.

In regard to histological findings we are still behind ophthalmology. If in case of intracranial pressure with exitus letalis the fundus is examined histologically the question whether there are symptoms of obstruction will have to be answered clearly, no matter whether there have been any local symptoms of the disease or not, as well as in the case in which no clinical examination has been made. In examining the ear in this way we must in view of the many technical manipulations (decalcification etc.) which are necessary for the procedure be very cautious and reserved when we discover histological changes in a case which either having no clinical symptoms or which has not been examined at all. It is known that the sensory epithelium and the cuticular portions of the labyrinth react rapidly and markedly both to change of pressure and to change of chemicals. The presence of artifacts is of considerable importance here in the histological picture. Hence also in this direction an improvement will be necessary inasmuch as we shall have to dispense with the decalcification in such case by clearing the membranous portions so as to examine histologically the wonderfully retained object. Improved clinical diagnosis of the labyrinthine disease and improved histological technique will point the way by which we shall solve the problem of the choked ear.

Although the study of the phenomenon of nystagmus is valuable both clinically and experimentally in labyrinthine affections nevertheless far greater progress will be made by widening our pathologico-anatomical knowledge of man.

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CLINICAL SURGERY

FROM THE II FRAUENKLINIK VIENNA

THE WERTHEIM OPERATION FOR CANCER OF THE CERVIX UTERI

By PROFESSOR DR. PAUL WERNER VIENNA AUSTRIA

THE RE is no other gynecological operation which carries with it so much danger and is so destructive as is the abdominal operation for cancer this is especially true if the operator is not familiar with the technique and does not know every detail necessary to prevent complications. The main dangers are a high primary mortality recurrence if radical removal has not been done and the possibility of damage to all the organs adjacent to the uterus. The organs to be considered most carefully are the urinary bladder ureters and rectum. The procedure which the II Frauenklinik formerly conducted by Wertheim has adapted with the hope of avoiding as far as possible the dangers associated with the operation is as follows

PREPARATION FOR OPERATION AND ANÆSTHESIA

The patient should not be examined by vagina or rectum for 3 or 4 days prior to operation and no excision should be made during this time. Every cancer is infected. Therefore any manipulation may force the infection into deeper tissue leading to a postoperative peritonitis or sepsis. Conforming with the e ideas we have recently abandoned curetting cauterizing or even packing the vagina as is done in many other clinics as a preparatory measure for this operation and in a large series of cases we have found that no harm has followed our practice.

The anæsthesia of choice is spinal 1 cubic centimeter of 10 per cent tropacocain given one half hour after 0.02 grams of pantopon subcutaneously. We have found that the use of spinal anæsthesia not only prevents postoperative lung complications and gives absolute relaxation to the abdominal wall to an extent not to be obtained in any other type of anæsthesia but also it makes possible the securing of an operative field from which the intestines are excluded so that we remove the chance of mechanical injury or infection to the intestines. A similar degree of relaxation of the abdominal wall can be obtained only approx-

imately by inhalation anæsthesia and the patient is then so deeply anæsthetized that life is endangered. As the intestines are never in the field of operation never manipulated and so never injured we are able to avoid irritating the peritoneum so often done formerly and also we are able to maintain almost normal peristaltic movements of the intestines after operation.

OPERATIVE TECHNIQUE

The patient is placed in the extreme Trendelenburg position. After the usual disinfection of the abdominal wall an incision is made from the umbilicus to the symphysis. It is important to extend the incision to the symphysis because resection of the deeper tissues is thus facilitated. Many of the difficulties encountered in these operations have been due to the fact that the incision was not carried down far enough. After walling off the pelvic cavity and placing a self retaining abdominal retractor the operative field is examined by inspection and palpation the glands the bladder the parametrium and the rectum. The most careful clinical examination will not always give exact knowledge of the existing conditions. If contra indications are not present the operation is begun as follows.

First step—separation of the bladder. The second assistant stands at the left of the operator and with his right hand pulls the vulsella attached to the uterus cephalad. The operator with a thumb forceps in his left hand lifts the peritoneum of the bladder at a point just between the insertion of the peritoneum on the uterus and its connection with the posterior wall of the symphysis in this way bringing up a long longitudinal fold (Fig. 1).

This fold is incised with blunt scissors midway between the forceps and the uterus. This incision is continued arch like on both sides to the round ligaments. Then the bladder is separated from the anterior wall of the cervix and vagina as far as possible. This must be done in the proper layer to avoid unnecessary bleeding. This proper layer—

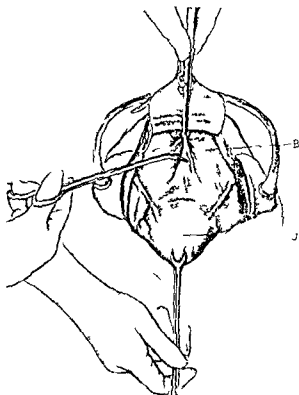


Fig. 1. First step in pelvic dissection.

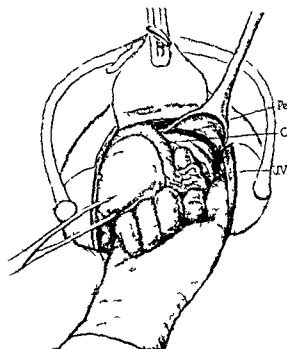


Fig. 2. Second step in pelvic dissection.

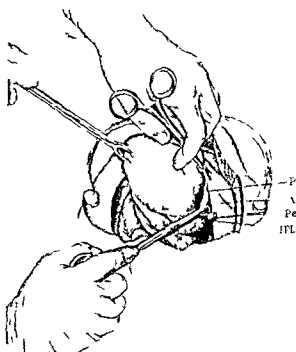


Fig. 3. Third step in pelvic dissection.

the connective tissue between bladder and cervix—easily found by lifting the bladder with forceps as high as possible and cutting the fold equidistant from each end.

Second step—separation of ureters. We always begin on the right side first by cutting the infundibulopelvic ligament between the ligature and the Pean's clamp. Then the two layers of peritoneum are separated by closed scissors (Fig. 2) until the opening is made large enough to introduce the right index finger and continued down to the lateral pelvic wall. A complete separation of the two layers is important so that the ureter may be speedily located.

Next the anterior or lateral layer is cut horizontally as far as the round ligament, the posterior or medial and then obliquely down to the pelvic wall. The exact cutting of the peritoneum is not only very useful in locating the ureters but is of greatest importance for a proper peritonealization of the wound after the uterus is removed. The round ligament is now cut and the ureter is located in the following manner. The second assistant pulls the uterus toward the symphysis and a little to the left, meanwhile the first assistant exposes the connective tissue of the broad ligament by pulling the stump of the infundibulopelvic ligament cephalad and against the posterior

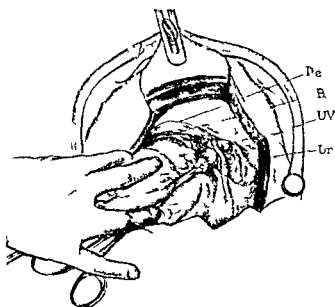


FIG. 4. The operative field after the vessels have been cut. *P* peritoneum *B* bladder *UV* uterine vessels *Ur* ureter.

abdominal wall. The cut edge of the posterior layer is grasped by the operator with a thumb forceps and dissection is carried down along the peritoneum to the location of the ureter, which is always closely related to the posterior layer of peritoneum. As soon as the ureter is found, the dissection is carried down to the bladder. The ureter is not dissected entirely free but is left connected with the lateral pelvic wall except in advanced cases when the entire pelvic connective tissue has to be removed. Then the ureter must necessarily be dissected free in its entire circumference. While dissecting down the ureter, one approaches an area in which the connective tissue fibers run in an arched manner over the ureter carrying the uterine vessels. As soon as this place is approached a tunnel is built by closed scissors blunt dissection above the ureter and below the arch-like fibers. Into this tunnel the right index finger can be introduced so that on the finger are the uterine vessels and below the finger is the ureter (Fig. 3). Under the guidance of the finger a silk suture is carried in a Deschamps needle under the vessels which are tied and cut. By this method we are able to avoid any injury to the ureter which in previous operations was very common. Figure 4 shows the operative field after the uterine vessels have been cut. Now it is easy to dissect the vesical ureter and the adjacent portion of the bladder as far down as possible (Fig. 5). A similar procedure on the left side frees the uterus in front and on two sides (Fig. 6).

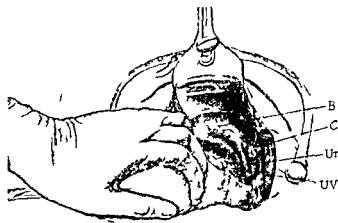


FIG. 5. Dissection of the vesical ureter and adjacent portion of the bladder. *B* bladder *C* cervix *Ur* ureter *UV* uterine vessels.

Third step—exposure of the posterior side and separation of the rectum. The rectum is dissected in the following way. The uterus is lifted out against the symphysis as far as possible. The first assistant is pulling the rectum out of the pelvis and pressing it against the promontory of the sacrum with his left hand (Fig. 7). In this way Douglas's pouch is flattened. This enables the operator to take up with a thumb forceps in his left hand a fold between rectum and posterior vaginal wall and cut it transversely. The incision is continued on both sides through the peritoneum of the sacro-uterine ligament to the posterior layer incision made primarily for the exposure of

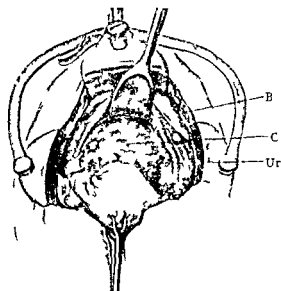


FIG. 6. The uterus free in front and on two sides. *P* bladder *C* cervix *Ur* ureter.

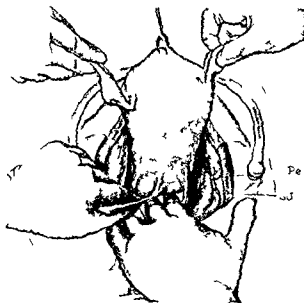


Fig. 7. The method of pulling down the uterus and the rectum. Douglas pouch is labeled 'Douglas p u h s'. The rectum is labeled 'R'. The uterus is labeled 'U'. The perineum is labeled 'Pe'. The illustration shows the uterus being manipulated, likely during a surgical procedure.

the ureter. The operator now grasps the uterus with his left hand and lifts it while separating the rectum from the posterior vaginal wall bluntly with the right hand down against the perineum. This is a rule is very easily done. The uterus is now free from all sides and can be extirpated.

11th step. We start as a rule with the right parametrium. By lifting the uterus forward and to the left side the parametrium becomes tense. Curved parametrial clamps (Fig. 8) are applied to the broad ligament as near the pelvic wall as possible beginning with the sacro uterine fold and going on step by step to the vaginal canal. The tissue is cut and when this is done on both sides the uterus is attached only by the vagina and can now be removed by cutting through. The opening of the vagina was formerly feared as the most dangerous step of the operation because then the infections of the carcinomatous area have their opportunity of entering the abdominal cavity. Wertheim tried to avoid this danger by applying two strong right angle clamps below the cancer to the vagina thus closing it beyond the dangerous growth and cutting below the clamps. This method without doubt will avert infection of the peritoneum through the vagina but it makes the operation very difficult because there is very little space for cutting the vagina below the clamps and the entire work has to be done deep in the pelvis. In the past few years we have avoided the dangers of infection in the following simple easy and satisfactory way

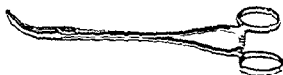


Fig. 8. The method of pulling down the uterus and the rectum.

12th step. As soon as the uterus is released from all its attachments except the vagina the latter is cleaned and dried out with dry pieces of gauze through the vulva. Then a gauze sponge is firmly pressed against the cancerous area and the vagina below the gauze pack is again cleaned. After this the operator returns to his place and grasps the vagina with his left hand by placing the thumb in front the index finger behind thus holding the gauze against the cancerous area and cuts the vagina below with scissors (Fig. 9). As soon as the anterior vaginal wall is cut a strip of gauze is introduced through this hole into the vagina to prevent any remaining contents from entering the field of operation. Then the vaginal attachment is completely severed and the uterus is removed. A few stitches are placed in the vaginal stump to control bleeding, and clamps are replaced by ligatures. By using the curved clamps which follow the pelvic curve the pelvis may be cleaned out entirely so not the slightest amount of fat or connective tissue remains. Figure 10 shows the left half of such a pelvis where the levator ani can be seen entirely exposed. After a exact control of hemorrhage the area is again examined for any enlarged glands. It must be remembered that such glands are always in close relation to the iliac vessel and of the obturator nerve and separation is often very difficult. Great care must be exercised not to ligate the obturator nerve as this would cause long lasting pain in the leg.

Finally a strip of iodoform gauze is placed in the operative field and an end extended through the vagina. The bladder peritoneum is sutured to the rectum and a suture is continued on each side to the infundibulopelvic stump which separates the entire operative field from the abdominal cavity (Fig. 11). The peritoneal apposition must be very accurately done in order to avoid postoperative peritonitis. Finally the abdominal lumen is closed in the usual way.

The difference between this extensive operation and simple extirpation is that the uterus alone is not removed but the adnexal or parametrial tissue and an extensive portion of the vagina. This is done in order to follow the general surgical law to extirpate a malignant tumor

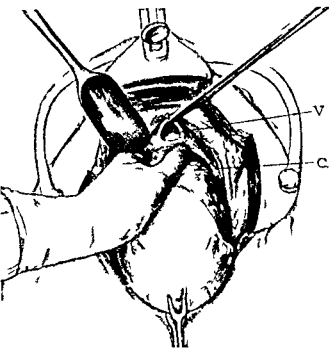


Fig. 9 With gauze held against the cancerous area the operator cuts the area below with scissors. The vagina is cut.

thoroughly so that only healthy tissue is left. This is possible only when preliminary dissection of the ureters—the most important point in the entire operation—is done.

AFTER TREATMENT

As in all other laparotomies the patient is put to bed and left absolutely quiet. There are no infusions or other medication given except a hypodermic injection of morphine 0.02 grams the evening after the operation to procure a restful night. Shock is never observed after the operation perhaps due to the fact that the intestines have not been manipulated. Forty-eight hours after the operation the patient receives an enema of chamomile tea to facilitate peristaltic action. If the bowels do not act after the tea enema the patient is given a glycerine water enema. On the fourth day the pelvic strip of gauze is partly removed and a little more is taken out each day until the eighth day when the last of it is removed. Five days after the operation the stitches are removed. It is advisable to have the patient brought to the examination table days after the removal of the gauze and to introduce forceps through the vagina into the parametrial wounds to permit the escape of any secretions that may be retained. This may occasionally prevent severe phlegmon of the retroperitoneal cellular tissue or secondary peritonitis. Especial care must be given the bladder. There is always complete

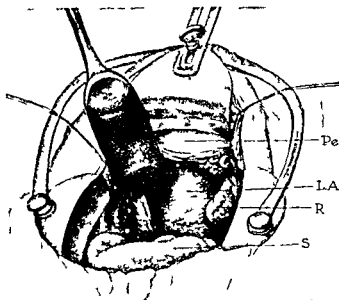


Fig. 10 Left adnexa entirely exposed on left side. *Pe* peritoneum *I* ileum *R* rectum *S* sigmoid.

retention of urine due to the extensive dissection and isolation of the bladder. This retention and the consequent cystitis cannot be prevented in fact it may be said that if a patient passes urine voluntarily after operation the operation was not a real extensive Wertheim. The operation by its extensiveness must lead to this bladder disturbance. The bladder must be emptied every 8 hours by catheter and washed with a 3 per cent boracic acid solution. After 8 or 10 days the patient starts to empty the bladder spontaneously but never completely. It would be a great mistake to stop the care of the bladder as a severe cystitis and perhaps even pyelitis might follow. The time for the end of the bladder treatment is determined in the clinic in the following way. The patient is asked to urinate in the morning and immediately afterward she is catheterized. The amount of urine found this way the so-called residual urine is measured. Only when no residual urine is found on 3 successive days does the bladder cease to require further treatment. This takes about 3 or 4 weeks.

Postoperative prophylactic radiation is done on every patient. For this only the X ray is used. Radium emanation does not reach deeply enough and even with most cautious dosage may lead to fistula because of the severely traumatized tissue.

The general rule is to be followed as always to radiate the patient as soon as possible but cautiously. If the radiation is started too early before the abdominal wall has had time to heal and the bladder is not sufficiently recovered severe recurrence of cystitis will follow and

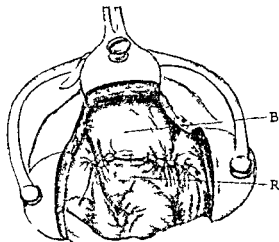


Fig. 1. Pelvic dissection showing the bladder (B) and rectum (R) in relation to the uterus and other pelvic structures.

require extended treatment. Therefore it is best to wait until there is but 10 or 20 cubic centimeters of residual urine before starting radiation.

COMPLICATIONS

The most common and most feared complication is the fistula. There may occur fistulae of the bladder, ureter, or rectum. This complication cannot be avoided entirely, especially in far advanced cases in which the growth has very closely approached the organs. Bladder and rectal fistulae are observed in the cases in which the cancer has grown close to these organs or even into the outer layer of their walls. The outer wall is removed with the growth and the remainder becomes necrotic and sloughs off as a rule within 8 or 10 days. Very little can be done to prevent this because even overlapping, with apparently healthy tissue does not as a rule prevent the fistula because of the tissue's diminished resistance and blood supply due to the extensive dissection. Nearly always rectal fistula will heal spontaneously, even though quite large. Bladder fistulae heal very rarely, even though they are small. After 3 or 4 months the fistula of the bladder must be operated upon and as a rule it heals with primary intention.

If adhered to certain rules, all reduce ureteral fistulae to a minimum. If possible the ureter should be left in contact with the lateral pelvic wall. If this cannot be done for instance in very advanced cases, Amann's method is the best way of reattaching the ureter to the pelvic wall by using the stump of the uterine vessels for fixation. The ureters should never be grasped with an in-

strument; all dissecting should be done by holding the surrounding connective tissue. Finally they should not come in contact with any ligatures or even the gauze used as a pelvic drainage. If after all these precautions a fistula does occur spontaneous healing may be expected in the greater number of cases. This healing may take place in some cases in 3 or 4 weeks, while in others it will require 3 or 4 months. Therefore surgical interference should not be tried until after this latter time. The only operation to consider is extirpation of the kidney because first it is impossible to dissect the ureter free from the scar tissue far enough to implant it into the bladder without tension, and secondly the kidney is nearly always infected at the time of operation and its preservation for this reason is not desirable.

Another severe complication is pyelitis. If 10 or 12 days after the operation and in some cases even later the patient suddenly develops high temperature which may or may not be accompanied by a chill, the possibility of pyelitis should always be considered, even though there is no pain in the kidney region and no urinary findings or any other symptoms common to pyelitis.

The kidney pelvis must be catheterized and it is best that the catheter remain for 24 or 48 hours to insure permanent drainage of the kidney pelvis and allow repeated douches of 1 per cent silver nitrate solution. If catheterization of the ureter is not possible due to severe changes in bladder mucous membrane it is advisable to place a permanent catheter in the bladder and twice a day inject 10 cubic centimeters of 40 per cent urotropine solution intravenously. Pyelitis if not treated or not treated early enough may lead to pyonephrosis and even to death.

RESULTS

Wertheim found that 50 per cent of the cases admitted to the clinic for cancer of the uterus could be operated upon; the remainder were inoperable due to the advanced stage of cancer growth or other complications. Of the cases operated upon 50 per cent were alive and well after 5 years. This corresponds to a permanent healing of 50 per cent of all cases operated upon or 25 per cent of all cases coming into the clinic with cancer. Since that time postoperative radiation has been used as a routine in all cases operated upon and the operative technique has been more improved so that the primary mortality has been reduced from 10 per cent to 5 or 6 per cent. I do not doubt that the future will show much better results.

I m r y m h d b e t e d t D H C H t I H
K n s a s f h l p t t t g t h s t t

FROM THE SECTION ON ORTHOPEDIC SURGERY, MAYO CLINIC

MASSIVE BONE GRAFT APPLIED FOR NON-UNION OF THE HUMERUS¹

BY MITVIN S. HENDLSON, M.D., F.A.C.S., ROCHESTER, MINNESOTA

FOR a number of years we have used the term massive bone graft to distinguish this type from the intramedullary or inlay bone graft. The intramedullary bone graft is placed in the medullary cavity, is gradually absorbed, and serves merely as a means of fixation. In cases of non-union it has proved of little value, and in cases of delayed union of but little more; therefore it has practically been abandoned. The inlay method, although anatomically accurate and seemingly logical, has certain faults. The inlay graft must be accurately placed in the slot prepared for it, or the necessary contact between the bone graft and the bone fragments will not be obtained. The most serious fault, however, is that the graft in some positions, particularly in the radius and ulna, is not of sufficient size to maintain fixation properly during the period from the third to the fifth week, which is often spoken of as the weak period of the bone graft. Although autogenous bone grafts are probably mostly absorbed and replaced by new bone, I doubt that this process is complete. At the time of maximal absorption of bone, there is not enough new bone in a small graft to provide real fixation, and it is then that the graft may break.

The massive graft overcomes these difficulties. It is easier to apply and is so large that it really acts as a means of fixation even through the period of weakness, because by that time enough new bone has been deposited. The massive graft is applied in the same manner as a metal or beef bone plate, except that the cortex of the fragments is freshened to expose fresh bone to provide nourishment for the graft.

TECHNIQUE

In order to illustrate the method of applying massive graft, I will describe the operation as carried out in a typical case of non-union of the humerus.

Incision and dissection. In operations on the humerus, the soft structures, particularly the nerve trunks, must be molested as little as possible. The musculospiral or radial nerve is particularly liable to injury because of its intimate contact with the bone in the musculospiral groove and its lateral position in the lower third of the

arm. This nerve traverses the arm posteriorly through the musculospiral groove close to the humerus between the heads of the triceps muscle; it comes forward laterally at the outer side of the elbow several inches above the outer condyle in the substance of the triceps muscle and soon enters the supinator longus; therefore it can readily be seen that although the lateral approach to a fracture of the humerus is more convenient for the surgeon, it jeopardizes the safety of this important nerve. I use an external anterolateral incision (Fig. 1a) curving the lower end across the tendon of the biceps. The dissection is carried down between the biceps and the triceps muscles and does not disturb the substance of the supinator longus muscle in which the musculospiral nerve divides into the posterior interosseous (motor) and the radial (sensory) (Fig. 1c). When this line of dissection is adhered to, the musculospiral nerve is well out of the way.

Exposure and preparation of fragments. The bone is exposed; the fragments separated (Fig. 1a) and the ends forced out through the incision so that the fibrous tissue between them can be removed (Figs. 2b and c). The end of each fragment is sawed off squarely (Fig. 3b) and the medullary cavity reamed out (Fig. 3a). The ends are carefully fitted together to make sure that the angle at which the bones were sawed off is such as to prevent bowing (Fig. 3d). The fragments are prepared for the reception of the massive graft by chiseling or sawing (Fig. 3c). A sufficient amount of the cortex on the side (the anterior surface when the external anterolateral incision is used) is removed (Fig. 3d) to expose the deeper bone which has a good blood supply. All vessels of any size in the arm are tied, and ends of the bone are wrapped in gauze sponges saturated with sodium chloride solution, and a small sponge is laid in the wound. The edges of the skin are drawn together by means of a towel clip. No tourniquet is used on the arm for fear of injuring nerves.

Removal of bone graft. It is usually better to use the tibia on the same side as the affected arm, because if it becomes necessary to use a crutch to relieve the strain on the leg, the patient will be more ambulatory, more quickly if he can use the crutch with the opposite arm. The bone graft

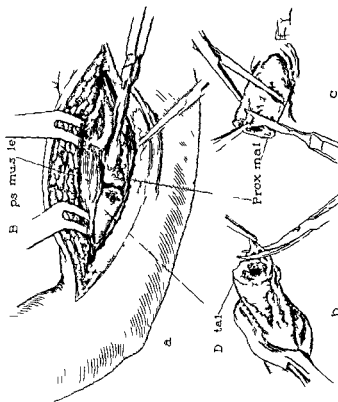
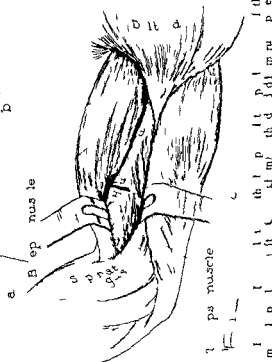
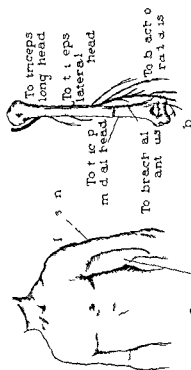


Fig. 1. The triceps muscle and its insertion.

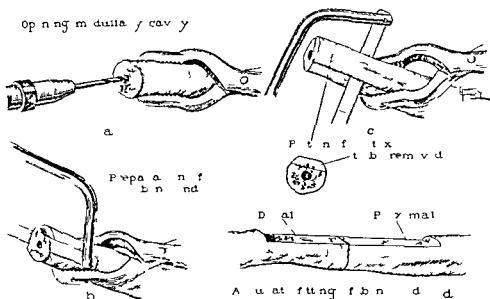


Fig 3 a Drilling the canal b smoothing the bone end c removal of the cortical bone d humerus prepared for graft

should be removed from the tibia as close to the upper end of the bone as possible and should include all layers. The end which originated near the epiphyseal line should be placed against the lower fragment because the bone cells near the epiphysis are more active in forming new bone. We know that practically all the growth of long bones takes place at the epiphysis not in the center of the shaft. Before closing the wound after bone grafting operations if it is possible to obtain scrapings with a curette from the epiphyseal area I pick them about the line of fracture. I am sure that our percentage of good results has been increased by the packing of these small grafts properly around the line of fracture. The incision (Fig 4) is curved to prevent it from coming directly over the site of removal of the graft moreover the distribution of the veins is such that the curved incision causes the least injury to the venous circulation (Fig 5). Figure 4 shows the leg prepared the tourniquet in place and the bones sketched in outline. The bone can be removed by means of a chisel and drill. The motor saw is quicker and more convenient but it should not be of such high speed

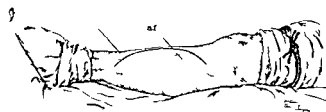


Fig 4 Showing the relation of the incision to the skin and bones

that it will burn the bone. Figure 6 shows the method of removing the graft and water being dropped on the saw to keep it cool. The graft is removed from the internal surface of the tibia the crest being left intact. Figure 6c shows

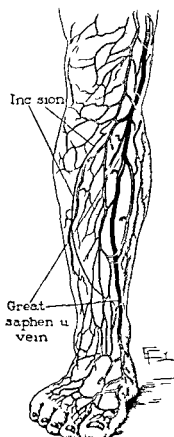


Fig 5 Shown the location of the incision in relation to the veins

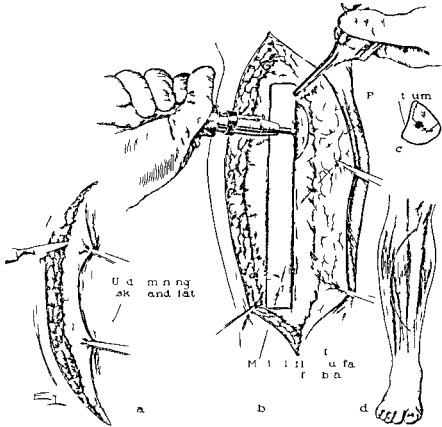


Fig 6 U d m n g th k fl p b t t l g ft h w g l t s
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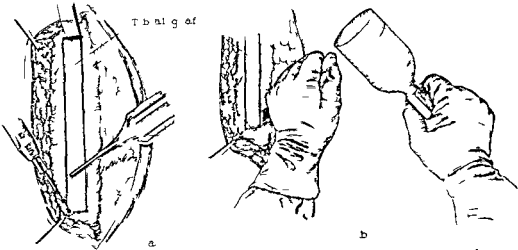


Fig 7 Sh n th d l l holes at th d of th g a f t b c h l p r y a n t th g r a f t

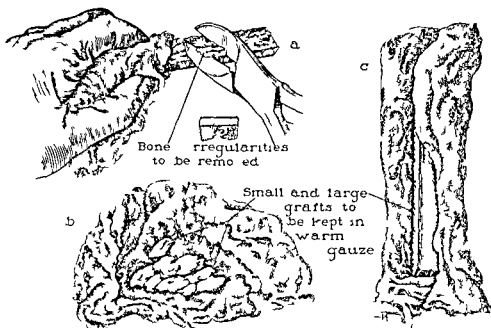


Fig. 8 a Smoothing the inner surface of the graft b and c small pieces of bone and large graft kept in warm gauze

diagrammatically the amount of bone removed. The removal of the graft is facilitated by drilling several holes at each end of the graft and freeing it by means of a chisel (Fig. 7a). Figure 7b shows the chisel being used to loosen the graft at the sides. The uneven pieces of cancellous medullary bone on the under surface of the graft are carefully removed with a bone biter (Fig. 8a) to give a smooth surface so that the graft can be applied to the prepared surface of the humerus. The graft and the fragments should be wrapped in a gauze

sponge and kept warm (Fig. 8b). The wound in the leg is closed and a firm dressing applied over it to prevent the formation of a hæmatoma. The tourniquet is removed.

Application of bone graft with beef bone screws

The ends of the humerus are approximated and the massive graft or plate of living bone applied to the prepared area on the fragments (Fig. 9). The ends of the fragments are pushed together firmly and the graft held in place by bone forceps. Means of holding this plate like graft to the

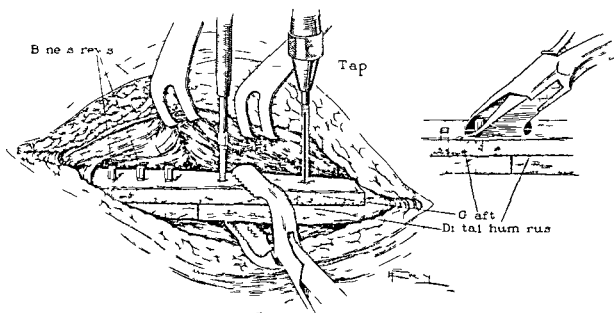
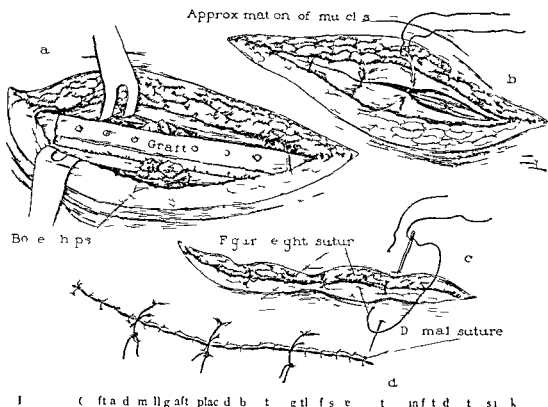


Fig. 9 a Drilling holes and placing bone screws b cutting off the heads of the bone screws



fragments may be provided by several different methods however I have found that beef bone screws serve the purpose admirably. Autogenous bone screws may be made with a dowel reamer at the cost of considerable time or autogenous pegs may be staggered into the graft and the fragments at various angles according to the method of Willis Campbell but the preparation of these pegs is also time consuming. The use of beef bone screws previously prepared saves considerable time. They are strong and retain their strength until the bone graft has become firmly united to the fragments. They must be made accurately so as to fit the threads that are tapped into the drill holes in the graft and fragment. Screws fitting too loosely are of no use and if they are too tight they bind and break as they are screwed in. Usually two holes in each fragment sometimes three are bored with either an

electric or hand drill through the graft and the fragments until the drill perforates the opposite cortex. After the screws are inserted the heads are bitten off (Fig 9). Before the wound is closed it is most important to pack multiple small grafts around the line of fracture (Fig 10a).

In bone grafts for non union or delayed union of fractures of the humerus postoperative fixation is essential. We have found that a body cast encircling the chest either resting securely on the iliac crests or hanging from the opposite shoulder should be applied a few days before operation. Following operation a cast should be applied to the arm forearm and hand extending from the ends of the metacarpal bones to the axilla and should be lashed securely to the body cast by plaster of Paris thrown around the body and arm cast and over the shoulder.

END-RESULTS FROM CORRECTION OF CYSTOCELE BY THE SIMPLE FASCIA PLEATING METHOD¹By NORMAN F. MILLER, M.D., Iowa City
A. t. P. f. so. Obst. t. I. Cy. I. gy.

FEW gynecological subjects have received as much discussion as cystocele the literature abounding with contributions dealing with various phases of the condition. Most of these papers have dealt with the technique of operative procedures, some have emphasized the cause etiology or treatment while only a few have reported end results from corrective operations. Since bulk of literature on a subject is often a bad rather than a good sign, one might well hesitate before adding to it. Yet it is only through this pooling of ideas that we may separate the chaff from the wheat and become familiar with the various procedures and corrective measures that are most desirable and so arrive ultimately at what may be considered nearest to the ideal.

The writer has long felt that while many operative methods for correction of cystocele give good results yet they are too complicated for general use and furthermore do not give better end results than some of the simpler procedures. In the hands of specialists such complicated methods have indeed a valuable place but it must be remembered that only a small portion of cystoceles are corrected by highly trained gynecologists and it should be apparent that the most satisfactory method will be the simplest procedure giving good results. With this idea in mind the writer decided to study the end results of the simple fascia pleating operation which is probably much the same method as is used throughout the country with minor variations common to the individual clinics and operators.

One hundred and fifty patients operated upon at the University Hospital by this simple fascia pleating method from 1920 to 1926 were studied the period since operation varying from 1 to 6 years. Each patient's record was carefully studied with particular reference to complaints which might have been produced by the bladder lesion. All of the patients were then interrogated by means of a questionnaire in order to verify their original entrance complaints to determine the results of the operation and if possible to ascertain their present condition. However only one hundred answers were received but in practically every instance the response was prompt and the answers were very concise and to the point.

To permit the better judging of the results obtained the method of correction used may be briefly described as follows. The cervix was grasped with a vulsellum forceps in the center of the anterior lip and pulled downward. A transverse incision $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length was made transversely across the anterior lip of the cervix just below the lowest point of bladder attachment (Fig. 1). Two Allis clamps were placed on either side of the midline of upper free edge (Fig. 2) and traction was exerted downward. The tip of a scissors was inserted between the mucosal and fascial layers. This was easily accomplished when the index finger of the left hand was placed on the outer surface of the mucosa and pressure made up against this finger with the scissors. The line of cleavage was very distinct and once found the scissors were pushed without difficulty up toward the urethra between the mucosal and fascial layers (Fig. 3). The blades of the scissors were separated and the scissors withdrawn and the separated mucosal layer incised in the midline up to within $\frac{1}{2}$ inch of the urethra (Fig. 4). The mucosal layer was dissected laterally each side being freed from the underlying fascial structures. This dissection was carried out as far as the lateral walls of the vagina on each side (Fig. 5). The bladder was then pushed up to a point beyond the region of the internal cervical os of the uterus. It was occasionally necessary to use sharp dissection to commence this displacement of the bladder but generally blunt dissection was sufficient. Carrying the dissection as high as the internal cervical os was important since we felt that in fixing the pubovesicocervical fascia at this high point the foreshortening of the anterior wall of the vagina would tend to prevent rather than produce backward displacement of the uterus. This completed the fascia overlying the bladder was pleated vertically by means of a continuous No. 1 chromic catgut suture which was started at the top and carried down toward the cervix the lower edge of the fascia being stitched to the cervix at the region of the internal cervical os. The pleating was then completed the same suture being carried back up to the starting point. In general no further pleating was necessary except in the larger type of cystocele when one or two additional pleatings

occasionally seemed advisable. The excess mucosa from either side was then trimmed off and the edges approximated with absorbable interrupted sutures care being taken to pick up some of the underlying fascia in order to prevent the formation of dead space. It is obvious that this folding or plecting of the fascia as described throws the base of the bladder into folds but this apparently does little if any harm. The operation outlined fulfills the requirement of being simple and from data obtained in this study is eminently satisfactory in so far as results are concerned.

In some instances other operations were performed at the same time thus most patients had a perineorrhaphy some a trachelorrhaphy others had a laparotomy for hysterectomy for suspension of the uterus or for appendectomy. The influence of these additional procedures upon the end results of the cystocele repair will be considered later.

SYMPTOMS ON ADMISSION

All complaints on admission to the hospital were carefully checked over and the frequency of each is shown in Table I. Backache a common complaint in women was included simply to note whether any relation existed between this symptom and the size of the cystocele.

TABLE I—SYMPTOMS ON ADMISSION

Symptom	Cases	Percentage
Frequency	63	63
Dysuria	54	54
Burning	5	5
Incontinence	43	43
Poturbation	8	8
Backache	8	8
Bladder prolapse		
Retention		1
Noted		1

Frequency, dysuria and burning are commonly associated with bladder disease of all types and for that reason are probably of no particular interest except in relation to the end results.

Incontinence is seen to be a particularly common symptom and it is of interest to note that this complaint was quite generally distributed regardless of the size of the cystocele or the age of the patient. Of the 3 patients operated upon for enormous cystoceles 2 complained of incontinence. This number is so small however that no conclusions are possible. In all other groups regardless of size this symptom was fairly common many patients noticing it on coughing, sneezing or laughing while others were incontinent even without straining.

Eighteen patients complained of backache. Of these 1 had a definite lumbosacral arthritis and 1 a sacro-iliac arthritis. Both of these patients were treated orthopedically and relieved of this symptom. Five of this group with a marked retroversion of the uterus were operated upon for this condition as well as for the cystocele. Four were completely relieved while 1 complained of an occasional backache but was otherwise improved. Of the 11 remaining cases who had no apparent disease to account for their backache 8 were reported as being completely well in all respects after correction of the cystocele while 3 still had occasional trouble. While 18 per cent of the women studied complained of backache it is difficult to determine the actual relationship existing between this symptom and cystocele. The fact remains however that out of 11 patients with backache and no demonstrable disease other than the cystocele and lacerations to account for it 8 were completely cured and 3 were improved by simple correction of this pelvic lesion.

The size of the cystocele was noted in all instances at the time of examination or operation and was classified as follows: enormous the size of an average orange, large the size of a lemon, moderate the size of a hen's egg, small the size of a bantam's egg or plum. On this basis the 100 cases grouped themselves as in Table II.

TABLE II—SIZE OF CYSTOCELES TREATED

Size	Cases
Enormous (orange)	3
Large (lemon)	15
Moderate (egg)	4
Small (plum)	43
Total	100

This classification was of value in many respects principally however in that it permitted the study of symptoms and end result in relation to the size of the cystocele. The best results were obtained in the larger lesions. Small cystoceles were noted in 6 of the 7 cured cases (86 per cent) in 10 of the 21 patients who were only improved (48 per cent) and in 5 of the 6 failures (83 per cent). Just why the results should be better in the larger cystoceles cannot be dogmatically stated. Possibly more painstaking care was exercised in the larger lesions or on the other hand the symptoms attributed to the small cystocele may have originated from another source and so were not relieved with repair of the cystocele. The relative frequencies of the symp-

toms in relation to the size of the cystocele are shown in Table III

TABLE III—RELATION OF SIZE TO FREQUENCY OF SYMPTOMS

	E N	m P	La g P	Mod t N	P t N	Sm ll P t
Number	3	15	40	4		
Frequency	3	100	9	60	8	0
Dysuria	3	100	6	40	23	57
Burnin		66	6	40	17	4
Incontinence	2	66	6	40	16	40
Protrusion		66	6	5	33	8
Backache	1	33	3	2	13	3

RESULTS OF OPERATION

Ninety four of the 100 patients studied reported themselves as perfectly well or definitely improved. Seventy two said they were perfectly well while 2 were definitely improved but did not consider themselves perfectly well and 6 stated they were no better after the operation. Complete cure in 72 per cent of the cases and definite improvement in an additional 22 per cent is certainly a sufficiently satisfactory showing to justify this method of repair.

INTERVAL SINCE OPERATION

Inasmuch as considerable time has elapsed since the operation in some instances 6 years this time element must be considered. The curative power of time is well known and its importance in this study is difficult to estimate. Table IV shows the results obtained in relation to years since operation.

TABLE IV—YEARS AFTER OPERATION IN RELATION TO CURES AND FAILURES

	C N	es I t	Imp t N	ed P t	F t N	es P t
One year after operation	7	58	3	5		16
Two years after operation	3	72	1	5		
Three years after operation	21	75	7	5		
Four year after operation	15	75	4	20	4	5
Five years after operation	18	66	6	7	5	9
Six years after operation	8	88	8		1	12
Total	7	72	22	2	6	6

COMPLETE CURES

The incidence of cures shows definite evidence in favor of the greater curability of the larger lesions. We see that the larger the cystocele the better the chances for complete relief. Thus cures were obtained in all (100 per cent) of the enormous cystoceles and in 12 (80 per cent) of the group classified as large but in only 31 (77.5 per cent) of the moderate and 6 (61.9 per

cent) of the small lesions. To be sure there were more of the latter treated and it is possible that this may partially account for the difference in percentage of cures but it seems that other factors must play an important role. It may be that in the larger cystoceles the removal of the visible tumor aids in convincing the patient that she is well. Moreover we may be misled and blame a small cystocele for symptoms of another origin. Table V shows the relation between results obtained and size of the cystocele.

A study of the patient's age with relation to results is shown in Table VI. It will be noticed

TABLE V—RESULTS IN RELATION TO SIZE OF CYSTOCELE

	E N	m P	La g P	Mod t N	P t N	Sm ll P t
No. of cases	3	15	40	42		
Cures	3	100	12	80	31	77
Improved			13	2	9	2
Failures			1	6	6	5

TABLE VI—RESULTS IN RELATION TO AGE OF PATIENTS

	T N	t id	C N	ed I t	Imp t N	d P t	p N	m P t
Age								
0-25 years	8	5	62	5			1	1
26-30 years	13	10	76	9	2	15	3	7
31-35 years	15	7	46	6	6	40		13
36-40 years	13	10	6	9	3	3		
41-45 years	14	9	64	2	5	35	7	
46-50 years	23	18	8	2	3	13		8
51-55 years	8	7	87	5	1	12	5	
56-60 years	5	5	100					
61-65 years								
66-70 years	1	1	100					

that the percentage of cures increased with the age of the patient. Thus the lowest percentage 46.6 per cent was at ages 31 to 35 while at 41 to 45 years the percentage of cures was 64 per cent at 46 to 50 years 78 per cent at 51 to 55 years 87.5 per cent and at the ages of 56 to 70 years it was 100 per cent.

IMPROVED BUT NOT COMPLETELY CURED

Of the 22 patients who were improved but not definitely cured 10 or 45.4 per cent gave incontinence as the only reason for considering themselves not completely relieved and 3 or 13.6 per cent had incontinence plus other bladder symptoms. Thus over one half of the improved patients had a residual incontinence. It is possible that some of these patients could have been cured had more care been taken in pleating the fascia in the region of the neck of the bladder.

The use of a mattress suture in this region preliminary to the pleating proper as mentioned by Neel (4) should be emphasized particularly in cases giving incontinence as one of their entrance complaints.

Table VII shows the number of patients reported as improved and enumerates the residual symptoms.

Incontinence stands out as the symptom most likely to remain after the operation. Forty-three patients had this symptom on admission and 28 of these or 65 per cent were cured. Thirteen of the improved and 2 of the non improved patients complained of incontinence after the operation, this being the principal cause for imperfect cure in the improved group.

TABLE VII—CASES IMPROVED ONLY

R E S I D U A L S										P	
I	t									0	4
I	t		d	b	v	f	i	s	b		
B	g	h	f	i						3	3
S	h										6
I	q	y									7
I	s	p									
I											4
I	m										4
											5

FAILURES

Six patients stated they were no better following the operation. In 2 instances the reasons given for the disappointment seem hardly valid since there were absolutely no bladder complaints. In another the result of the operation was perfect for 13 months at which time confinement caused a recurrence of the cystocele and the original complaints (Table VIII).

TABLE VIII—FAILURES

R E S I D U A L S									
B	k	h	f	i					
P	f	t	l						
P									
N	b	i	d						
C									
I									

It is obvious that the complaints given by 2 patients with cancer of the cervix the other with gastro intestinal symptoms can hardly be attributed to failure in curing the cystocele. Moreover 1 patient had been perfectly well for 13 months when the lesion returned following

confinement. These cases cannot be classed as primary failures although in studying end results they must be so grouped. A corrected list of failures would show 3 or 3 per cent.

The fact that more patients did not have trouble after the operation is particularly interesting when we consider the work of Broun and Rawls (). These investigators made cystoscopic studies of the bladder condition in 49 patients after operation for cystocele. Although this study was not confined to the results of any one procedure it was shown that visible folding of the base of the bladder was common following such operations. From the results of our study it seems doubtful whether this bladder distortion is particularly important in the production of symptoms later on. Certainly the base of the bladder must be folded in all operations based on pleating of the pubovesicocervical fascia. A comparison of these end results with those obtained in patients operated upon by the fascia overlapping procedure as advocated by Neel (4) Spaulding (7) Rawls (5) and others would be particularly interesting in this connection. In the latter operation there should be little if any bladder distortion provided the fascial dissection is carried out sufficiently toward the lateral walls of the vagina. This overlapping procedure is frequently used in our clinic with very good results but the number of cases operated upon up to the present time is not sufficient to permit a comparison.

That the end results are better in the larger cystoceles is further evidence to show that folding or distortion of the base of the bladder is unaccompanied with serious consequences. Certainly the degree of folding or distortion of the bladder base and ureters must be considerably greater in the larger lesions where the amount of pleating is necessarily more than in a small cystocele.

RETROVERSION FOLLOWING OPERATION

The question of retroversion follows in this operation is an important one since no procedure can be considered satisfactory if in correcting it another lesion is produced. Many operators make it a point to perform a suspension operation whenever a cystocele is repaired. In our clinic this has been done only when a marked retroversion was found at the time of operation. Accordingly the suspension operation was necessary in only 5 of the 100 cases. As previously mentioned the fixing of the lower edge of the pleated fascia at least as high as the internal cervical os was insisted upon. By this maneuver we hoped not only to raise the bladder but also to prevent the occurrence of postoperative retroversion due

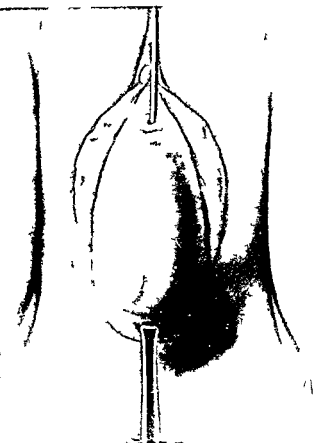


Fig 1 Showin how the cervix is pulled down. The uterine sound in the bladder shows the extent of the cystocele

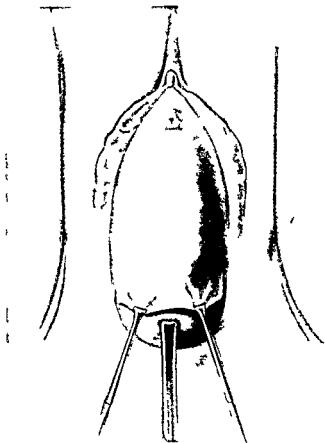


Fig 2 Showin the transverse incision just below the bladder reflexion (Compare with Figure 1) Clamps have been placed on the free edge of the mucosa

to foreshortening of the anterior vaginal wall Neel (4) suggested that the lateral mucosa with the underlying fascia be advanced to the midline of the cervix and sutured in that region as a means of preventing the tendency toward posterior displacement. In this series 3 patients had a retroverted uterus at the time of their discharge examination. Since it was impossible to get these patients to travel from various points in the state back to the clinic for follow up examinations it is impossible to say how many more developed retroversions at a later postoperative period. The fact that only 3 cases showed displacement nearly 3 weeks after the operation however may be taken as evidence that this occurrence is not common. We would expect

most displacements to appear during the first few weeks although it is possible that some occur later as a result of scar tissue formation and contraction. If by this procedure we also lessen the chances for retroversion as we feel we do then it has an added advantage over those procedures in which laparotomy for suspension is necessary.

POSTOPERATIVE MORBIDITY

The various reasons for the postoperative fevers occurring in this group are shown in Table IX. Any temperature over 100.4 degrees for 2 or more consecutive days was considered as definitely febrile. The uncorrected morbidity rate was fairly high due largely to 4 infected laparotomy wounds (in instances of combined operations) which can scarcely be included in a morbidity study of a specific cystocele operation. Some patients showed a slight separation of the mucosal edges without evidence of infection and were kept in the hospital a few days longer until complete union had taken place. Only 1 infected perineum was noted in the entire 100 cases and this occurred in a patient suffering from diabetes mellitus. The morbidity rate for cystocele correction

TABLE IX.—POSTOPERATIVE MORBIDITY

Cases	C
Infected perineum (diabetic)	1
Infected laparotomy wound	4
Erythema	1
Tri-omni bladder infection(?)	1
Lung infection(?)	1
Cause undetermined	3
Total	11

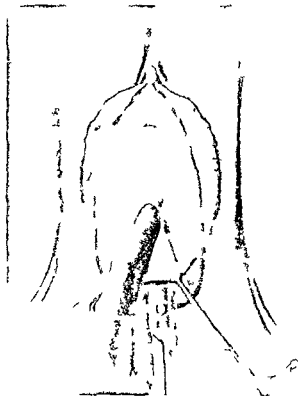


FIG. 3. Scars have been made in the right side of the abdomen, the incision being made in the line of the old scar. The incision is made in the line of the old scar.

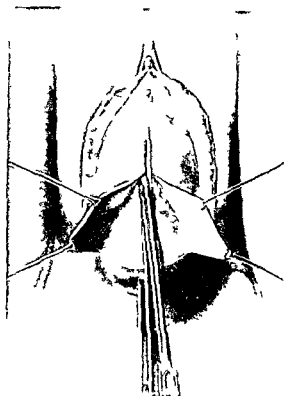


FIG. 4. In the middle of the uterus, a small incision has been made in the line of the old scar.

should be very low since drainage from the operative field is good, the blood supply excellent and infections in this region are not particularly common.

CONVALESCENCE

Each of the 100 patients studied was asked how long a time had elapsed after the operation before relief was noted. Twenty-four were relieved immediately or within the first few weeks after the operation while in 9 cases improvement was noticed between the first and second month after operation, in 26 after 3 to 6 months and in 5 after 6 months to 1 year. Thirty or 30 per cent reported having been gradually relieved while 6 were not improved.

Doubtless many factors tend to vary the time needed for recovery, such as the size of the cystocele, the severity of symptoms previous to operation, the age of the patient and no doubt the environment into which she goes on returning home as well as the actual operation all of which must be considered in this connection. When a laparotomy has also been performed the convalescence may be prolonged due to greater

drain on the patient's physical resources. Age too must play a part. Our youngest patient was 19 years of age and the result was excellent with only a few weeks required for complete disappearance of all symptoms. On the other hand the oldest patient was 69 and the result was excellent after 6 months. The average age was 41 years. While syphilis, diabetes, cardiac or renal disease may also be a factor in determining the end results as well as the duration of the convalescent period, such complications were not common. One patient had a positive Wassermann reaction and was intensively treated previous to operation while another was a diabetic. Neither was completely cured, each complaining of some bladder disturbance. In neither instance was the healing particularly delayed although the diabetic had a mild postoperative infection of the perineum.

EFFECT OF LAPAROTOMY ON END RESULT

It seemed that the removal of uterine fibroids or pus tubes and the correction of uterine displacements would insure better results in the cystocele operation but our findings indicate that such combinations are in fact detrimental and

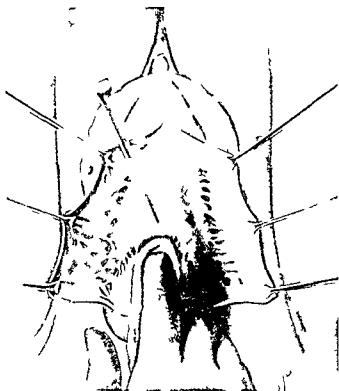


FIG. 5. Showing the mucous membrane incised up to within one half inch from the urethra. It is separated from underlying fascia to lateral wall of vagina. The bladder and its fascial covering are being separated from the cervix and pushed up to a point beyond the internal cervical os.

that patients operated upon for cystocele without the necessity for laparotomy have a better chance of perfect cure.

Table V shows the types and numbers of the 31 abdominal operations performed in the various groups of patients. Only 17 were among the 72 patients recorded as cured (23 per cent) and 10 among the 21 improved cases (45 per cent) while of the 6 failures 4 (66.6 per cent) had a combined operation. It would thus appear that combining plastic and abdominal work has a distinctly detrimental effect upon the former.

SUBSEQUENT PREGNANCIES

Twelve patients reported having been confined since operation. Eleven deliveries were normal and only one patient had a recurrence of the cystocele with symptoms (8.3 per cent). This patient aged 29 years was perfectly well for the 15 months following her operation and preceding the confinement. Following delivery, which was normal, the cystocele and original symptoms apparently returned. The size of the baby at the time of birth was not known. The operative confinement was a cesarean section at 7½ months for toxæmia of pregnancy. The fact that this patient had previously had a normal deliv-

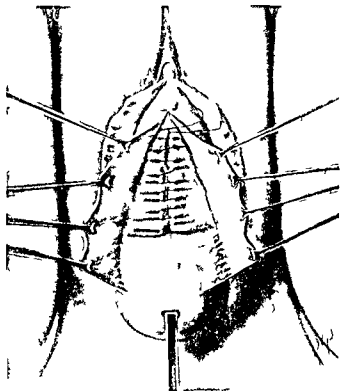


FIG. 6. Plication of the pubovesicocervical fascia (fascia overlying the bladder). Note the point of fixation to the cervix at the lower angle of the plicated fascia.

TABLE V.—LAPAROTOMY COMBINED WITH CYSTOCELE REPAIR

Operation	Number		Improved		Total
	C	D	I	F	
Radical Wertheim after repair of the cystocele	3	1			4
Carcinoma as found in piece of cervix removed at time of cystocele operation					
Subtotal hysterectomy for fibroids	4		1		5
Subtotal hysterectomy and salpingectomy for inflammatory disease			1		1
Anterior suspension with appendectomy	2		3		5
Anterior suspension only	7		4		11
Appendectomy only	1		1		2
Closure of perforating wound of uterus					
Total	17	10	4		31
Percent	23.6	45.4	66.6		

ery would indicate that in all probability she would be grouped with the normally confined were it not for the toxæmia treated by cesarean section. One of the group had a stillbirth. This patient aged 39 was perfectly well following operation. One year later when 3 months pregnant she was operated upon elsewhere at which time a myomectomy and appendectomy were

A METHOD FOR THE GRADUAL OCCLUSION OF THE AORTA

BA HERMAN L PEARSE JR M D BALTIMORE
F m t h r l H u t L b o t r y f t h J h H p k M d l h o o l

OCCCLUSION of the aorta has been performed in man in 2 instances. This daring operation was usually undertaken for the cure of aneurism of the abdominal aorta. Though in some instances the patient was cured of the aneurism he usually succumbed from secondary hæmorrhage due to a cutting through of the occluding device. From the time the aorta was first ligated by Sir Asterly Cooper (7) in 1817 to the present there has been no method of procedure to secure occlusion of this structure which does not subject the patient to grave danger of death. The surgeon is confronted with a curable disease which is certainly fatal if untreated yet which must be avoided surgically because of a lack of a proper method of procedure. A suitable method must have several attributes: (1) it must avoid secondary infection such as occurs with clamps or snares which protrude outside the skin; (2) the occlusion must be gradual in order to allow compensation of the circulation; (3) finally compression of the arterial wall must be avoided since the expansile pulsation quickly weakens this structure and rupture follows.

A method is described which embodies all these principles and in addition is relatively easy of technical performance.

HUMAN CASES

Clinical experience in this field is relatively limited but very illuminating. Fourteen of the 2 cases died within 3 days from shock or circulatory derangement as a result of sudden occlusion. Two cases survived the effect of ligation but died in 10 days and 48 days respectively from secondary hæmorrhage. In all of the remaining 6 cases a method of gradual occlusion was used and these patients survived from 41 days to over a year. In addition there are 3 cases in which internal suture of the aneurism was attempted. All patients died from hæmorrhage within a few hours since the aortic wall would not hold the sutures well. From these cases it may be stated that:

1. Sudden ligation of the human thoracic or abdominal aorta is usually a fatal procedure.

Suture of the diseased wall is unsatisfactory.

3. Gradual occlusion is the only hopeful method.

The best procedure for gradual occlusion thus far devised is the Halsted aluminum band. That

this is not satisfactory for use on the human aorta may be judged by Halsted's (10) words. I have applied an aluminum band to the human aorta 4 times twice in one subject and twice with promising results so far as the cure of the aneurism is concerned. But the experimental work on animals had led me to expect that ultimately the metal bands must cut through the artery because in cases observed 7 months or less the wall of the aorta had become atrophied to the thinness of paper and there was no adhesion between the infolded attenuated surfaces. That my fears were well founded was proved by an experience in Europe about 18 months ago. The patient was an aged woman with dilated and badly functioning heart. The large aortic aneurism was well located for the placing of a band which was applied just below the renal vessels. Within a few days the aneurism which before operation was distinctly visible from the seats of the operating amphitheater was barely discernible at the bedside and at the end of 6 weeks had disappeared so completely that the patient was discharged apparently cured. But walking out of the door of the hospital she was seized with a pain and returned to her bed. The following morning she died from hæmorrhage. The aorta had ruptured at the site of the band but the aneurism was found to be nearly cured. Thus the search for other procedures is justifiable.

EXPERIMENTAL RESEARCH

During the century following the first case of ligation of the aorta in man much experimental work was done regarding it. The two main objects of this work were to determine the effect of ligation on the organism and to devise a successful mechanical means of carrying out the procedure. Pirogoff (19), Sonnenburg (3), Kast (12) and Kuemmell (11) showed that ligation of the aorta was a feasible procedure in animals that it caused no harm to the heart and lungs and that the peripheral circulation quickly returned. Allen (1) found that partial occlusion of the abdominal aorta with an aluminum band followed in about 10 days by ligation causes no apparent disturbance to the animal.

The collateral channels have been demonstrated by Porta (6), Kast (12) and more recently by Reichert (1).



F Th t a t f l t p r

The majority of these experiments on animals were done on the abdominal aorta below the origin of the renal arteries.

The experiments to obtain a proper mechanical means for occluding the aorta have been numerous and many ingenious devices have been conceived for this purpose. The earliest attempt to avoid the sudden shutting off of the circulation in this great vessel was by means of a rubber tourniquet which encircled the abdomen and compressed the aorta from without. This was occasionally followed by trauma to the abdominal viscera and rupture of the intestines was not unheard of. Because of this fact Milton (17) suggested a rubber tourniquet which went over the aorta and out on either side of the spine so that it might be tightened at will without trauma to the viscera. This was never attempted in man.

The next step was the use of a metal clamp or snare of silk, catgut or metal which protruded from the abdomen and was tightened or loosened from the outside. Such instruments have been devised by Keene (13), Stratton (24), Dubois (8), Assolini (3), Burjalsky (4), and Cooper (6). All had a common purpose, that of gradual occlusion of the aorta, and all had a common fault, namely, liability to secondary infection. Dr. Halsted (10) in a preliminary report on the use of his aluminum bands said: "The notion of gradual compression in the ordinary use of the term was entertained only to be definitely discarded because of the seemingly insurmountable difficulty of preserving asepsis. A sinus must form about any instrument leading from the aorta to the air and sooner or later such a sinus necessarily become infected. This objection is an important one for in few fields is asepsis so essential as in vascular surgery. Infection uniformly predisposes to secondary hemorrhage."

The next contribution was one of the most important steps in the surgery of the great vessels, namely, the introduction of the partially occluding band by Halsted (10). He showed that a

partially occluding aluminum band applied to the abdominal aorta of a dog would eventually result in complete obliteration and this was called the ideal closure. It has been mentioned that Halsted was not entirely satisfied with his band for use on the human aorta. However, it has been of great value not only for use in situations in which sudden obstruction is dangerous, such as with the innominate, subclavian, carotid, femoral or popliteal arteries, but also in the elucidation of the principle of an epic gradual occlusion of the great vessels. Thus it has served its purpose well.

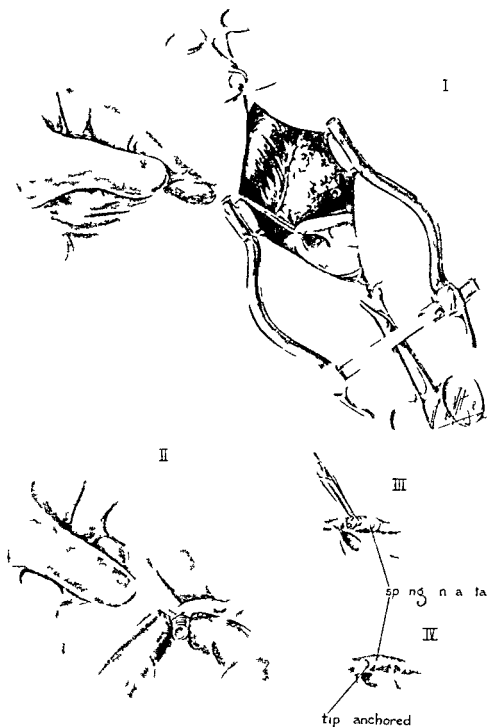
Halsted also tried ligatures, tapes and tissue bands to occlude the aorta. He says: "Fine silk cut through in 2 days; coarse silk cut through more slowly. Knotted ligatures were found to be unsuitable for a desired degree of constriction or obliteration could not be accurately obtained nor could the crushing of the arterial wall be invariably avoided. Tapes of various materials were tested—of cotton, of chromicized intestinal submucosa, of elastic tissue obtained from the aorta of aponeurotic white fibrous tissue. These were applied in spiral or cuff form. These tissue bands always relaxed and allowed reestablishment of the lumen. Haecker (9) and Holman (11) have given additional proof that encircling, partially constricting sutures or ligatures are almost invariably followed by fatal secondary hemorrhage."

One of the most promising investigations on this subject was contributed by Matas and Allen (16). These authors brought about constriction of the thoracic aorta in 151 dogs by plicature mattress sutures. The plication was increased at subsequent operation and in some instances the lumen was all but obliterated. Peid () has recently confirmed these observations. But it has been stated that in the 3 cases in which suture of the diseased arterial wall was attempted in the human, the patients died of hemorrhage. If stitches would not hold.

Thus the methods for occluding the aorta are clamps or tourniquets which protrude from the wound, ligatures partially occluding, tape, fascia or metal bands, and sewing of the arterial wall. None of these methods is entirely satisfactory for the purpose.

EXPERIMENTAL METHOD

There are certain facts stated above that are worthy of note by those interested in interpreting experimental work on this problem for use in the clinic. It has been observed that two-thirds of the cases of sudden occlusion of the human abdominal aorta resulted in death from shock. The



I The technique of introducing the spring **I** the thoracic aorta exposed
II the tip of the spring thrust into the lumen **III** the spring turned parallel to
the artery and introduced by rotation **IV** after introduction

is not the case with dogs. Further, in those human patients surviving the occlusion, the majority died later from hemorrhage due to cutting through of the occluding device. This rarely occurs in the abdominal aorta of dogs. But on the other hand, animals do not tolerate sudden oc-

clusion of the thoracic aorta and any partially occluding device applied to this structure usually results in death from secondary hemorrhage. Reid states: "Partial occlusion of the thoracic aorta with bands or ligatures cannot be done either in man or dogs without grave danger of



Fig 3 Fig 4
 I 3 Th am t of thrombos i mpt t
 b tru t
 k 4 Tl dr lt A m ll ca l h s p f t d
 th tl mb

Fig 5 Fig 6 Fig 6b
 Fig 5 A pt d th acc t e k aft th
 ppl t f an lum um b d
 F 6 Th a t c ll () k l (b) f ks
 ft the m to f p g

fatal hæmorrhage. Here the great pressure of the blood and the scant periarterial support hasten death of the arterial wall and prolong the period of repair with fibrous connective tissue.

Therefore occlusion of only the thoracic aorta of the dog is comparable to that of the human aorta throughout its extent. In testing the value of an occluding device it is obligatory to use the animal's thoracic aorta; erroneous interpretations may thus be avoided. This has a further advantage in that since sudden occlusion results in death the efficiency of the gradual occlusion may be determined by the life of the animal.

All previous methods of arterial occlusion have depended upon compression of the arterial wall from without. Experience has shown that compression is not feasible when applied to the aorta since the great expansile pulsation thrusting against the compressing agent causes the arterial wall to weaken and rupture. There is however a natural mechanism for occluding arteries that has never been put to use, namely thrombosis. Petit (18) first showed that this is nature's method of controlling hæmorrhage.

It is conceivable that if the thrombus could be easily produced and adequately controlled it would be an ideal method for gradual closure of the aorta. It was thought that if metal or glass tubes of various lengths and diameters were placed in the lumen of the artery the thrombotic process could be controlled so as to give a gradual

complete occlusion. The technical difficulty of this procedure is great. The artery must be opened between rubber shod clamps, the tube introduced and tied in place. This procedure may produce obliteration of the lumen but it is too difficult for practical use. In this regard it is of interest to recall experiments of Carrel (5) who reports 10 instances of intubation of the thoracic aorta with glass or aluminum tubes. Most animals died a few days after the operation and despite careful preparation of the tubes with paraffin a thrombus was usually formed in them. One dog lived for 3 months and the tube remained patent. Carrel interprets this to show that aortic blood can flow through a glass tube for more than 3 months without the occurrence of an obliterative thrombus. However it is not improbable that a thrombus had been formed and was eventually resorbed.

It was conceivable that a metal tube consisting of coiled wire like a spring (Fig 1) could be screwed into the lumen through a small perforation in the arterial wall. This was tried experimentally and found to be satisfactory in every respect.

OPERATIVE PROCEDURE

Adult dogs who received 4 grain of morphia and ether anesthesia by tracheal insufflation (Meltzer Auer Method) were used in every case. The animal was placed on the right side and after the usual skin disinfection and draping an inci-

sion of about 4 inches was made over the eighth intercostal space. This was carried down through the intercostal muscles, all bleeding points were clamped and ligated and the chest was opened. The pleura over the thoracic aorta was picked up and incised and the arterial wall exposed. A tape carried by an aneurism needle was passed under the artery and used for traction (Fig. 2). The aorta was gently lifted and steadied with the left hand. This procedure results in a partial obstruction of the lumen with consequent proximal distention of the artery that greatly facilitates the introduction of the spring. The coiled wire was grasped with the right hand, the sharpened tip thrust into the lumen and the spring rotated 1 or 2 turns to hold it in place. It was then grasped with a clamp, turned parallel to the arterial wall and introduced by rotation until only a small tip remained outside the lumen. This was left in place and served to anchor the device and prevent hæmorrhage through the perforation. The first step was accomplished without hæmorrhage. In some cases when the spring was turned parallel to the artery the perforation was stretched so that a small jet of blood under high pressure escaped. If this was disregarded and the tip of the spring left out a moment's pressure with a sponge stopped all bleeding. The entire procedure has been carried out without completely soiling one sponge. As a rule 3 or 4 sponges were used, but the bleeding is no more than that caused by the incision in the thoracic wall.

EXPERIMENTAL RESULTS

At the time of the insertion of a metal spring into the thoracic aorta, the proximal and distal pulse is the same. Within 15 minutes the pulse proximal to the spring is slightly diminished. At the end of 30 minutes a well marked thrill is present which increases in intensity to a maximum in approximately 1 hour. If the peripheral (femoral) blood pressure is recorded during this stage it is found that the systolic pressure falls and the pulse pressure is diminished. The fall in systolic pressure is not marked until complete occlusion occurs, at which time it drops suddenly, only to rise gradually as the collaterals dilate.

It was found that the time required for complete occlusion varied in different animals and with various procedures. Trauma accelerates the thrombus formation and is to be avoided. The research of Aschoff (2) has shown that the platelets which form the framework of a thrombus are apt to be deposited in the eddy below an obstruction. A spring consisting of a series of small elevations will produce multiple small eddies

along the arterial wall and the resultant thrombus will have many points of origin. Hence the number of coils in the spring and the size of the wire will influence the rate of thrombus formation and consequently the rate of obliteration of the lumen. Welch (25) in his exhaustive monograph points out that the character of the surface may alter the process of thrombosis. He shows that a smooth non-adhesive wall gives poor attachment for the platelets and conversely that irregularities promote the process. In view of this fact any indentations on the smooth surface of the wire would tend to accelerate the obliteration. It is of interest to note that different metals apparently influence the rate of thrombosis. It was thought that copper and brass produced thrombi most quickly. Steel springs result in a slower thrombotic process than do those of brass or copper while surgical silver wire was the slowest of all metals to produce obliteration. Silver plated steel springs are midway between the latter metals. Further experiments to test this point are to be conducted for if subsequent results confirm the present impression then surgical silver wire which is commonly used for the wiring of aneurisms is the poorest metal for the purpose. For the present work either polished steel or silver plated steel springs were adequate. The rate and amount of thrombosis caused by these metals gave obstruction of the lumen slowly enough to be tolerated by the animal.

Following completion of the operative procedure the dog has an uneventful recovery from the anæsthetic. There is no indication of air hunger so commonly seen after too sudden obstruction of the thoracic aorta. The femoral pulse becomes slight and completely disappears in about 6 hours. For a period of about 3 days there is apt to be slight weakness of the hind legs. The animal then appears to be perfectly normal and is able to run for a short distance without fatigue.

The fate of the thrombus produced in this manner is important in determining the end result. It is not generally appreciated that a thrombus is most essential for hæmostasis with or without the use of a ligature. Kocher (14) believed it to be the most important factor in the immediate and final suppression of hæmorrhage. The size and shape of a thrombus which had just previously caused complete obstruction is shown in Figure 3. It is to be expected that thrombi in the aorta will eventually canalize, how soon and how much this occurs is the deciding issue. From the examination of a series of specimens it was found that canalization of any consequence begins in from 4 to 6 weeks, a lapse of time ade-

TRANSPLANTATION OF THE GLUTEUS MAXIMUS FOR PARALYZED GLUTEUS MEDIUS¹

BY DAVID R. TELSON, M.D., NEW YORK

TO paraphrase Lovett the disability resulting from paralysis of the gluteus medius is a perpetual lesson in humility. The limp resulting from this paralysis is most unsightly and one that no brace is in the least able to correct. The patient with gluteus medius paralysis thrusts the foot on the afflicted side forward and realizes that as soon as the opposite foot has left the ground the paralyzed gluteus medius unable to act as a guy rope on the afflicted side will allow a shift of the torso toward the normal side. He therefore makes efforts to prevent this; he uses the trunk muscles to shift the lateral center of gravity to the afflicted side and lurches throwing the entire torso to the paralyzed side. By this maneuver he is able to lift the normal foot from the ground and still maintain his balance.

The gluteus medius and minimus are the only effective abductors of the thigh. The medius is also the principal internal rotator of the lower extremity accomplishing this through its anterior fibers. The patient with gluteus medius paralysis will therefore walk with an external rotation of the limb in addition to the lateral limp.

There have been several operative procedures devised to overcome this very disabling deformity. Lange uses a series of silk cords to connect the origin of the vastus externus to the crest of the ilium. The connecting cords spread out in fan shape from the muscle below the trochanter and passing subcutaneously are attached to the crest of the ilium. Legg transfers the insertion of the tensor fascia lata to the posterior aspect of the shaft of the femur by suturing the fascia lata tendon superiosteally to the femur, or 3 inches below the trochanter. Dickson also uses the tensor fascia lata by transferring its origin from the anterior superior spine to the vicinity of the posterior superior spine.

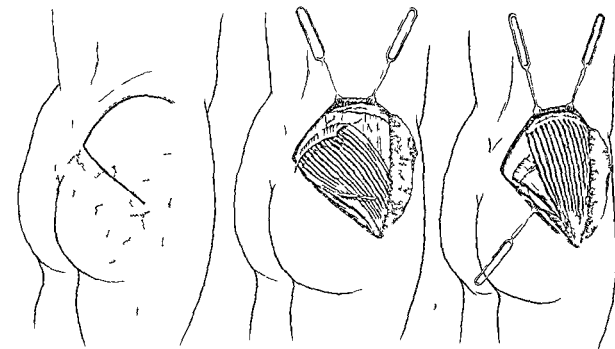
In the Dickson operation it is of great advantage to have only a weakened and not a totally paralyzed medius and in the first two methods gluteus maximus paralysis should be a contraindication. Lovett says that in his group of cases in which the Lange operation was used some were improved but in no case was the limp obviated. Legg states that of 3 cases operated upon by his own method in 3 the limp was entirely done away with and in 8 others the gait was improved.

Lange has devised an operation for gluteus maximus and medius paralysis which consists in mobilizing the lower end of the erector spinae and by means of long silken strands transferring its pull to the greater and lesser trochanters. Mayer has modified this using a longer powerful tube of fascia which envelops the lower end of the erector spinae and is implanted into the posterior aspect of the femur for maximus paralysis and into the greater trochanter for medius paralysis. Ober working independently has used a smaller strip of fascia which is sewed into the fibers of the mobilized lower end of the erector spinae.

In treating the gluteus medius paralysis one must be particularly careful of involuntary substitutionary movements. A child has two methods of attempting to mislead. When placed directly on the unaffected side and ordered to lift the affected limb the child either flexes the thigh and externally rotates thus bringing the hip flexors into the lateral plane or else internally rotates the thigh and turns the part forward thus bringing the anterior fibers of the gluteus maximus into the lateral plane. These two substitutions are impossible in walking. The first cannot be utilized inasmuch as the hip are extended when the shift from one foot to another is attempted and the second method cannot be brought into play for the medius is the chief internal rotator of the lower extremity and with its paralysis the limb rotates outwardly and throws the gluteus maximus directly posteriorly and out of the lateral plane.

From the observation of this second method of substitution it is readily seen that if the lateral half of the gluteus maximus origin is transferred into the lateral plane we will accomplish surgically what the child has always been attempting to do functionally.

An incision is made from a point over the prominent tubercle on the crest of the ilium about 1/2 inch in back of the anterior superior spine describing an arc 1 inch proximal to the crest of the ilium and ending posteriorly at a point over the great sciatic notch. The incision is then carried diagonally across the buttock in direction of the fibers of the maximus to a point just above the great trochanter. The skin and subcutaneous fat are reflected back exposing the



1

Fig. The k o b g s at the t b e l t l
t of the l m a d follows th t t th lo e b r d
f the c t n c l It th o n t u d n th d r e c t n
f th fib s of th gl t s m m u m u l e to th gr t
t h t
1 2 Th p t f t l e gl t s m m s h g

2

f l o l t d t l b a h e f the up r
gl t l e l p d f gl t l r e
F 3 Th l a t a p t f th gl u t m m
w n t o l y n d t f c a w t t t h t f
t l l u m a f a r f d s t h t l c l n h s p t t
t h a t : u p r p e

3

fascia covering the gluteus maximus and a heavy pad of fat over the fascia covering the paralyzed gluteus medius. This fat is dissected out and an incision is made through the fascia investing the gluteus medius just anterior to the fibers of the gluteus maximus and parallel to it. The hand is then passed deep to this fascia underneath the gluteus maximus and the loose connective tissue separated. The entire fascial origin of the gluteus maximus is then severed just above the crest of the ilium some of the fascia covering the erector spinae being taken with it. The great sciatic notch can now be defined by the palpating finger and at its extreme lower border that is below the piriformis muscle the heavy fibers of the gluteus maximus are bluntly separated dividing the gluteus maximus into approximately one portion with fascial origin and the intact portion arising from the sacrum, sacrotuberous ligament and the coccyx. When the fascia on the deep surface of the maximus is reached in the dissection one must be certain that the lower border of the piriformis has been reached. Since success depends upon this all important step of the operation we are doubly cautious continuing

the separation from above downward at the posterior edge of the transplant till the inferior gluteal nerve is brought to view.

As the inferior gluteal nerve comes from below the piriformis it divides into portions passing latrally to enter the portion of the muscle having fascial origin and the other passing medially to enter the osseous portion of the muscle.

The superior gluteal vessel will not present any difficulties as they are embedded in a column of fat and are well protected. The lateral portion of the maximus is then swung anteriorly and its fascia is sewed into the crest of the ilium and a portion of the flare of the ilium from which the paralyzed gluteus medius has been stripped.

The factor limiting the arc of transplantation is the length of the branch of the inferior gluteal nerve. This will be found to be ample to allow implantation of the maximus a far forward as the tubercle on the crest of the ilium carried in the lateral plane. The procedure is completed with the limb in abduction. A plaster of Paris spica is applied and the extremity kept in moderate abduction for 3 weeks at the end of which time voluntary exercises are begun.

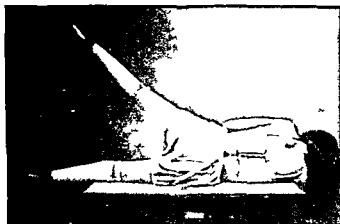


FIG. 4. Abduction of the left hip after transplantation of the left gluteus maximus

The gluteus maximus according to Morris arises from distinct anlagen in the embryo and its separation in the adult does not entail great difficulty. I feel that the operation is mechanically sound in view of the fact that the mass of muscle transplanted is greater than that of the original gluteus medius. This I think is a great advantage over using a comparatively small muscle like the tensor fascia lata. Secondly the line of pull is a straight one and the leverage is much more advantageous than that of the original gluteus medius as its origin is much higher than that of the paralyzed muscle. The portion of the gluteus medius having fascial origin has also fascial insertion into the fascia lata and its line is directed along the outer aspect of the limb with an extremely effective leverage. Reeducation in the use of the transplanted muscle is very simple inasmuch as the child has been attempting to use the maximus as an abductor ever since it was paralyzed. The principles of muscle transplantation are all complied with in the above paragraphs and in addition we have transplanted the fascia covering the muscle *en masse* with the muscle so that the possibility of adhesions forming are negligible.



FIG. 5. Demonstrating negative Trendelenburg sign after transplantation of the left gluteus maximus

The child shown in the illustrations operated on in Mayer's section of Fred Albee's service at the Post Graduate Hospital is able to abduct the extremity with power equal to that on the other side. The lateral sway of the body and the Trendelenburg sign have entirely disappeared. The operation of course can be used only in a carefully selected group of cases in which a powerful gluteus maximus is present. However the same selection must be used in the Legg and Lange operations. It is entirely feasible to combine the Dickson operation of transplantation of the origin of the tensor fascia lata with the transplantation of the maximus.

Acknowledgment is made of the kind help of Leo Mayer in perfecting the technique of this operation.

ZINC-GELATIN DRESSING IN THE TREATMENT AND ATTIRE- TREATMENT OF FRACTURES

BY DR. ERITZ SCHNEK, M. D.
V. I. L. B. H. I. C. F. H. V. A. I. I. O. P. J.

Of all medical problems the treatment of fractures is the one most frequently concerned with mechanical methods and for this reason the mechanistic viewpoint of fracture treatment is apt to be overemphasized. Treatment however demands not only considerable knowledge of all types of splints and bandages, a thorough anatomical training, and a complete understanding of the complicated mechanical conditions present but also necessitates considerable manual dexterity. The very best dressing is worthless if it is incorrectly applied either because of carelessness on the part of the practitioner or because the technique is too complicated for general use. There is a vast degree of difference between bandaging in a hospital where all the modern facilities are at hand and bandaging under emergency conditions without the aid of trained assistants and the best equipment. Considerable dexterity is necessary to bandage a patient quickly and with the necessary care. An ill-fitting dressing does its duty badly or not at all and thereby causes the patient unnecessary pain. However, experience has taught that it is almost never advisable to do over a poorly applied dressing, hence one must make every effort to have the initial treatment as perfect as possible.

It must be remembered in the use of a new method for the first time that no matter how accurate and detailed the description of the technique may be, nothing can overcome the handicap of unfamiliarity with a technique but repeated practice. No one who is employing a technique for the first time can possibly have the dexterity of the experienced physician who has all the detail at his finger tips. Furthermore small mistakes during the initial attempt to follow a new technique may not only lead to failure in that instance but may also lead to the abandonment of a really valuable method.

Because of the fact that a number of courses given at the Vienna Accident Hospital for the American Medical Association have shown that the advantages of the zinc-gelatin dressing in the treatment of fractures are unknown to many American physicians I wish to describe here the uses for and the technique of this dressing.

The zinc gelatin dressing is a semi-elastic dressing consisting of 4 layers of a loosely

woven cotton bandage the meshes of which are filled in by the thick fluid of zinc gelatin. The dressing was first introduced by Unna for the treatment of leg sores and it proved very valuable in such cases as it not only does not irritate the skin but may cure open ulcers and eczemas. Furthermore as the bandage sticks well to the skin and prevents the occurrence of edema the dressing is even more practical for the treatment of fractures than is irritant court plaster. The constitution of zinc gelatin is as follows:

Zinc oxide puriss	100 g
Gelatin alba	100 g
Aqua fontana	300 g
Glycerin	400 g

It is advisable to use only the very best materials in the preparation of the mixture since otherwise the glue is not absolutely reliable.

PREPARATION OF THE MIXTURE

The zinc oxide is mixed with just enough water to make a thick paste; after this paste has been well mixed and stirred it is mixed with the glycerin. The gelatin which has been softened in cold water must be freed of as much water as possible by squeezing well with both hands. The gelatin then contains just 3 parts of water i. e. no more water need be added. It is then put on the water bath and stirred constantly. It becomes fluid in 5 or 10 minutes. Then the zinc-oxide-glycerin mixture is added and after a few minutes stirring the glue is ready for use. It is advisable to prepare a large quantity at one time pour it into a shallow dish and cut the elastic mass into smaller pieces. Then whenever some of the mixture is needed a few pieces are put on the water bath and warmed up *without adding water* until they become fluid and are ready for use. It is not necessary to add a disinfectant or preservative.

Organdie bandages 10 and 15 centimeter in width should be used. This material because of its broader meshes absorb the thick glue much more readily than ordinary bandage material. A 10 centimeter broad flat hair (not bristle) brush is used to paint the mixture on the skin and bandage. In order to keep the zinc gelatin fluid during the process of painting it on the bandage the pot of glue should be kept in a



Fig. 1. Pure zinc gelatin cut in pieces broad and narrow bands.

pan of hot water. Two pounds of zinc gelatin are sufficient for 5 dressings of the lower leg.

GENERAL TECHNIQUE

A few pieces of zinc gelatin are put on the water bath to warm. As soon as the glue is fluid it is brushed over the *unshaven* skin and the bandage laid on in spirals under slight tension. The edges of the bandage must not cut into the skin since disturbances of circulation would thus arise. For the same reason no folds are made in the bandage. Instead the bandage is cut when ever it does not fit well and is begun anew from that point. After the first layer of bandage has been put on a new layer of glue is brushed on and then another layer of bandage is put on in precisely the same manner as the first until 3 layers of bandage and 4 layers of glue have been put on.

The last layer of zinc gelatin will dry in 20 minutes and after that it will not soil clothing or linen. If one is in a hurry the last layer of glue can be covered with a layer of cellulose or treated with a solution of 6 parts of formalin in 94 parts of alcohol. The dressing remains on for 2 or 4 weeks until it has either become soiled or loose. It can then be replaced by a fresh dressing if necessary. The bandage is removed by cutting it up the anterior side and then jerking it off suddenly so that the pain due to the pulling out of hairs is reduced to a minimum. In patients who perspire freely the bandage soon becomes loosened. In order to keep it tight it can be treated with the solution of formalin in alcohol.

AN EXTENSION DRESSING IN FEMORAL FRACTURES

The general treatment of fractures of the femur cannot be considered here. Succinctly such fractures are treated by extension dressing on a Braun splint. The extension is made directly on the bone by means of a Steinmann peg which is driven through the tuberosity of the tibia. This peg is removed in about 3 weeks and replaced by a zinc gelatin extension dressing.

The following technique is used. The glue is brushed on the thighs, the hips and circularly



Fig. 2. a Calico bandage b Gauze bandage c Organ die bandage

around the abdomen and then a layer of organ die bandage is laid on. A second layer of glue is put on next and is followed by a layer of calico bandage 10 centimeters wide which is put only on the lateral sides of the thighs from the inguinal region to the middle of the femur. Glue is spread on top of this. The ends of the longitudinal calico strips are turned in to prevent later slipping and are fastened by circular layer of bandage. The dressing is finished in the usual way with the bandage forming a regulation spica in a thigh to belly direction. The longitudinal strips of calico should not be fixated except above the femoral condyles as they would otherwise cause disturbing pressure upon the latter. The dressing is allowed to dry for a day while the extension weight is still acting upon the Steinmann peg. The following day the two longitudinal strips are connected by a V shaped wire stirrup and the weight transferred from the peg to the thigh.

After the peg has been removed the lower leg and the knee are covered with zinc gelatin. A layer of bandage is placed over that then as on the previous day a medial and a lateral longitudinal layer of calico is laid from the knee down to about 30 centimeters beyond the sole of the foot. Then the dressing is finished just as on the thigh, totaling 4 layers of zinc gelatin and 3 layers of bandage. The ends of the thigh bandage and the dressing of the lower leg must cover each other very well as otherwise a disturbing so called interstitial oedema would occur. The soft parts at such a point are oedematous and protrude from between the bandages so that ulcers may occur at the penetrating edges. The 2 longitudinal strips on the lower leg must not be fixated down to the malleoli but must be free of the skin from there down as ankle pain would otherwise occur. The dressing is completed as follows: the ankle and the foot are pruned with glue. Then a strip of calico is stretched from the heel over the sole of the foot to about 30 centimeters beyond the toes and a similar strip from the joint of the foot over the dorsal side to the same distance beyond the toes. The usual alternate layers of zinc gelatin and



1 3 Bru h n the n g l a t i u l l a u d t h
a n k l i n t d k l b B a j g r u l l a u n d t h
k l j i n t a d a k l B h n g l t i n l t n

f t h l o v l y d W a d n a t h b n d e t h e l o l g
c T l t n l d g l t n d n m p o d f a l y
f z g l t a d z l a f b n d

bandage are put on. The anterior strip serves to keep the leg from rotating and the foot from moving into a *p equinovarus* position. It is also necessary in this case to see that the ends of the second bandage and the last one overlap so that a *lema* will not occur. The bandage reaches as far as the basal phalanges of the toes; the latter being kept free. The knee joint and the ankle joint are slightly flexed during the dressing so that the bandage will not cut and cause pain later on when movements are begun.

The day after the entire dressing has been completed that is if the parts over the lower leg and the foot have dried sufficiently, the traction strips on the lower leg and the foot are also replaced by a V shaped wire stirrup as above connecting the parts of the bandage; the extension weights are then equally divided between the upper and the lower peg. The traction on the foot passes by means of pulley over the bed and thus holds the foot in slight dorsal flexion. In this way active and passive movements can be started even with constant extension on the fragments and without the displacement of these fragments and resultant pain.

If however the patient begins to complain of pain this indicates that the dressing has been put on too tightly at that point and must be cut open with scissors. If any vessels are found they should either be left alone or opened with a sterile instrument and covered with sterile gauze. Under any circumstances the patient must be carefully watched for the first 18 hours to see whether or not the toes keep warm and arterialized and whether or not they can be moved. If any unfavorable signs appear the whole dressing must be carefully looked over since either a paralysis of the peroneus nerve at the head of the fibula or an initial circulatory disturbance may result from a tight fitting bandage. In either event it is best

to cut the dress in up the front and renew it after a few days.

Zinc gelatin dressing will not irritate the skin even after months of use and should remain in place until it becomes loose. Depending upon the extent of movement and exercise and upon the degree of consequent muscular atrophy this will occur in 3 to 6 weeks. Then a new dressing is put on in precisely the same manner as before. For the first day only the thigh and hip part is replaced with the extension acting on the lower leg and the following day the weights are transferred to the femur so that the lower leg and the foot can be dressed.

In order that the joints may be used it is sufficient to take off the weight on the pelvic extension and transfer the weights from the lower leg to the upper leg. The hip joint can be exercised by the patient sitting up in bed and then lying down again. In this way all the joint can be exercised with the fragments constantly in line and fixed.

The zinc gelatin dressing may also be very practical in the treatment of painful *repairs* of medial fractures of the neck of the femur. *Boehler* has demonstrated.

In such a case the technique is as follows. The patient is immediately bandaged just as in the case of femoral fractures except that the fact that extension is dispensed with and it once it is finished the dressing is completed with all its 3 extension strips and no pelvic part. After a few hours the knee joint is stretched and the patient fixed to the lower end of the bed in adduction position by means of the strip on the lower leg. The lower end of the bed is then raised about 60 centimeters higher than the head of the bed. The patient thus hangs entirely by his injured ex-

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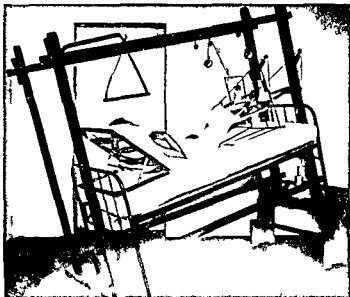
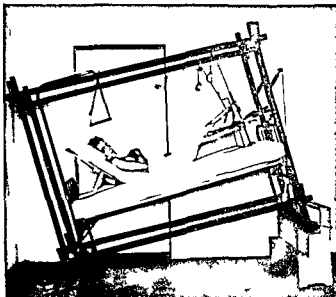


FIG. 4. a and b Bilateral fracture of the femur complete zinc gelatin extension dressing on the left thigh only

th femur part of the dressing is finished and the Steinmann peg still acts on the lower leg

extremity. Simultaneously the tendency of the leg toward medial rotation is enhanced by a suitable form of lateral traction. Twenty-four hours later the ends of the fragments are in good position. This can be corroborated by X-ray and Shoe maker's line.¹

As soon as the satisfactory position of the fragments has been determined the case is treated as a typical fracture of the femur: the leg is put on a Braun rack and the weights equally placed on the strips of the upper and lower leg. The advantage of this method is that no narcosis is necessary, particularly in old persons—and most of these cases are among the aged, thus precluding the danger of pneumonia.

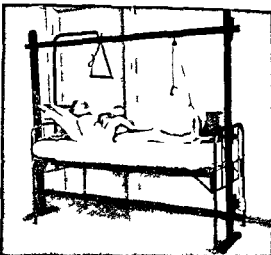
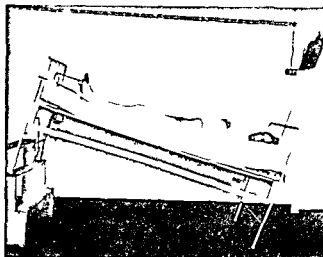
In *pelvic fractures* the zinc gelatin stretching type of bandage makes it possible to preclude the pain resulting from the movements of the extremities. For this purpose the dressing is put on so that it reaches from the inguinal region to the basal phalanges of the toes with the knee stretched. The only extension strip attached is on the lower leg and this passes over the pulley at the lower end of the bed and is loaded with 6 pounds. This slight extension is decidedly pleasing to the patient, since superfluous movements of the leg are avoided and the pain resulting from necessary movements disappears.

The zinc gelatin dressing plays an important role in the *after treatment* of fractures of the entire lower extremity. The first attempts at walking

after any bone injury to the leg or foot provoke a livid discoloration and swelling caused primarily by a disturbance of the circulation. The very best treatment of a fracture cannot enable the leg to stand up under normal usage; the result is a muscular atrophy which in turn leads to faulty circulation in the extremity and produces oedema which damages circulation and nutrition. The oedema in turn causes an atrophy of the bone and this naturally weakens the carrying capacity of the leg. This is in short a vicious circle which depends for revision upon a well functioning circulation. We are able to avoid all of these complications if we are in a position to restore normal circulation. A means to this end is found in the zinc gelatin dressing which possesses many advantages over other dressings. This bandage remains in place for some time without loosening whereas the usual bandage material soon becomes loose and must be changed frequently. This dressing does not prevent perspiration as does an elastic stocking or other dressings and therefore prevents ulceration due to secretions. Zinc gelatin dressing enhances the epithelization and healing of any ulcers present under its protective covering since such a process is also dependent upon good circulation and tissue nutrition. The precluding of oedema permits the patient to walk. In other words we afford the patient the best possible conditions for healing simply by means of this dressing and without any further after treatment.

The type of dressing used for after treatment reaches from the popliteal space to the basal

Sh m l l ect th m j t och t w th th t
s ne p d p jec l gh ly bo th l h lhy d d l
s bel w t l bel w h h iz l l t t f th
t och t d d ase f th h p j t



1 5 7 8 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

phalanges of the toes. The technique is as follows:

The patient lies on a table with the lower legs hanging over the edge. Since the foot shall be in slight flexion when the bandage is put on in order to keep the dressing from cutting in the ankle joint later it is well for the patient's foot to rest on the doctor's knee during the procedure so that the flexion may be controlled. The foot is placed on the knee with the region of the fifth metatarsal down in order to create suitable pronation of the fore foot. This pronation of the fore foot is very important for the preservation of the arch. A more detailed discussion of the prevalent ideas on the genesis and treatment of flat feet will be given later.

As soon as the position of the knee and the foot has been fixed, the zinc gelatin is brushed on the unshaven skin around the ankle joint and heel to a breadth of about 5 centimeters. A double layer of bandage comes over this, then more glue, then another double layer of bandage. Then the entire lower leg is brushed with glue from the tuberositas tibiae down and the bandage laid on in spirals under slight traction. If the spirals do not fit the leg, new ones are made in the bandage instead of the bandage is cut with scissors—not torn—and union atresh. The incisions must overlap so that no skin is left uncovered. As soon as the calf and shin have been covered with a layer of bandage the zinc gelatin is brushed over the bandage which is already in place on the ankle joint and heel as far down as the basal phalanges of the toes and the dressing continued. As soon as the first layer of bandage has been laid on the

zinc gelatin is brushed on and the dressing repeated. As in the case of the dressing for the thigh 4 layers of glue and 2 of bandage are sufficient here, these layers are augmented in the region of the ankle by the 2 double layers of bandage put on at first. This is necessary since the greatest part of the body weight rests upon this part and the bandage needs greater strength at this point. The last layer of zinc gelatin is either covered with cellulose or hardened with the formalin alcohol solution. The entire bandage must not be thicker than a heavy stocking so that in the case of an out patient a shoe can be put on over the bandage.

The dressing leaves the toes completely untouched and reaches to just under the tuberositas tibiae on the shin side and up to the popliteal fossa on the posterior side so that free motion of movement at the knee is possible. If the bandage is made shorter on one side or on the other then the limb becomes oedematous and the edge of bandage cut into the skin and provoke sore formation.

In patients who perspire freely the dressing is rubbed down daily with the formalin alcohol mixture. Since the dressing does not irritate the skin it may remain in place from 1 to 4 weeks. Usually however patients with a marked pruritus oedema will eliminate in a few days with the dressing loosened. This is simply a sign that the oedema has diminished and if the dressing is needed for the reason the zinc gelatin dressing should be applied immediately after the removal of a plaster of Paris cast before any swelling appears. In cases with particularly marked edema the dressing should be put on with the leg

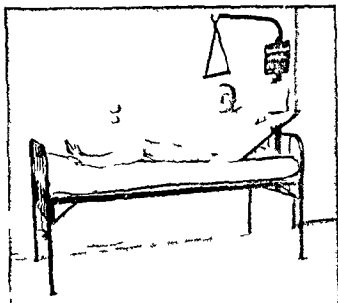


Fig. 7. Zinc gelatin dressing for the lower leg for the purpose of stretching the knee joint.

raised or in the morning, after a night's rest has produced a decrease in the swelling of the extremity. The time between bandagings should be as short as possible in order to preclude the possibility of any fresh oedema. The dressing is changed as frequently as is demanded by the presence of oedema, but the patient is neither kept in bed nor from his work.

The uses mentioned do not include all to which zinc gelatin bandage may be put. I also wish to describe a method which combined with extension treatment can be used to advantage for the *painless stretching of flexion contractures of the knee*, as in arthritis deformans, distal femoral fractures, injuries to the knee, etc.

The zinc gelatin is laid on from the popliteal space to the basal phalanges of the toes and a medial and lateral strip of calico is glued in longitudinally and fixed as far down as the malleoli just as in the case of the dressing for the femur. This traction strip on the lower leg is passed over a pulley at the foot of the bed and weighted with 4 to 6 pounds. This equal and constant traction soon straightens the knee joint.

Zinc gelatin dressing is used in *contusions and sprains of the ankle and the foot* which are too slight for a fixation bandage and yet cause trouble when the patient walks. In such cases the zinc gelatin bandage has also displaced the ordinary bandages and elastic bands. It is always surprising to find how quickly the patients are freed from pain as soon as the dressing is put on. This dressing is particularly valuable in the treatment of athletic injuries, since it permits a rapid return of move-

ment. It is especially remarkable that the feeling of insecurity in such cases soon disappears.

The especial province of zinc gelatin dressing however is that great class of diseases and complaints in outpatients resulting from *pathologically changed posture*. From cases of weak feet to the most severe forms of contracted flat foot, from the shin bone fractures which have healed with a slight axial deviation to severe compound fractures of the calcaneus, there is a chain of complaints which arise from the same cause. Abnormal static conditions as a result of unphysiological functioning of the joints.

There is no doubt that a certain congenital weakness of the connective tissue apparatus plays a definite role in flat foot. This is also the reason why such patients also frequently disclose the varicose syndrome, muscular weakness, and later obesity—all depending more or less upon the same constitutional anomaly. These conditions also have their bad effects on flat foot. In the later stages the incongruity of the articular surfaces leads to an arthritis deformans just as in traumatic complete flat foot, this causes pain and keeps the patient from walking. This in turn causes atrophy of the already weak muscles because of inactivity and lack of body exercise and leads to further increase in weight, which has the same unfavorable effect upon circulation that the reduction in functional usage has and promotes the incidence of varicose veins and ulcers. The patient is then forced to stay in bed and thereby loses the last vestige of muscular activity.

This vicious circle can be broken only by the restoration of movement in the extremity. To this end a well made and individually fitted arch supporter is necessary, so that the movement in the joints of the foot may be rectified, such a method could be aided if necessary by a corrective operation. A second point is the restoration of good circulation. A zinc gelatin dressing not only helps the ligaments to function well, but also helps to heal any leg sores, prevents the incidence of oedema, and makes it possible for the patient to walk. Exercise strengthens the patient's muscles, avoids too great an increase in weight and promotes good circulation. This dressing causes an immediate improvement of the disability which is reflected in the improved walking ability. The method of dressing is the same as that for the lower leg. The dressing remains in place as long as it is not loose and is changed as often as there is oedema. This condition often lasts for months but is not harmful, since the dressing does not irritate the skin and the patient can keep at work.

THE MOST COMMON METHODS OF GASTROSTOMY WITH THE REPORT OF A MODIFIED TECHNIQUE OF THE JANEWAY METHOD

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A d t A t i s s g th M m 1H pt l

THE term gastrotomy (gastro stomie from γαστήρ stomach and στήν mouth) was coined by Sedillot in 1846 to designate the operation for creating a permanent gastric fistula for feeding purposes. The Greek word γαστήρ also means abdomen and with this meaning the term gastratomy had been in use for many years to designate any operation in which the abdominal cavity was opened. This inclusive use of the term gastrotomy continued throughout the greater part of the 19th century, occasionally being misspelled gastrotomy, resulting in a confusion of terminology which renders a search of the literature often both misleading and unproductive.

The establishment of a permanent gastric fistula as a means of alimentation in oesophageal stricture was first proposed by Egeberg (8) of Christiania in 1817. He conceived the procedure after having witnessed the death of a young man from starvation and thirst as the result of oesophageal diverticulum and stricture. Dilatation of oesophageal strictures by sounds and bougies was an accepted method of treatment at the time but in this case had failed. One can not but be impressed by Egeberg's clear conception of the soundness and utility of an operation which he was for the first time proposing. He even suggested the employment and emphasized the safety of retrograde bougienage through the fistula for dilatation of the stricture as an added indication for the operation but he never put into practice what he was first to conceive.

In 1841 Watson (35) an American surgeon independently advocated the procedure in intractable oesophageal stricture and contended that it seemed rational and feasible.

In 1846 Sedillot (5) of Strasbourg who was at the time unfamiliar with the earlier observations of Egeberg and Watson began the publication of a series of articles on the nature of oesophageal strictures, advocating as a rational procedure in their treatment the operation for which he coined the term gastrostomie. His proposal was received with considerable disfavor. Gendron (11) in the same year denounced the proposed operation as preposterous, foolhardy and unjustified, contending that the passage of sound and bougies was a much more rational method of treat-

ment and was perfectly satisfactory. In spite of the classic observations of Beaumont (published in 1833) which were already quite well known, others questioned whether food taken in such an unnatural way could be digested and assimilated. All those who advocated gastrostomy based their contentions of the soundness and practicability of the establishment of permanent gastric fistula on the following well known facts: that persistent gastric fistulae often followed wounds of the stomach (especially in war) and that they sometimes persisted for years and were compatible with good health. Surely their propositions were sound. They had witnessed accidentally acquired fistulae of the stomach which persisted without fatal results. Why not construct one and utilize it as an avenue of alimentation when the normal one no longer served? Sedillot (3) in 1841 first performed gastrostomy on dogs and was successful in several cases using the animals for study of the physiology of digestion.

In 1849 Sedillot (27) first performed the operation on man in the case of carcinoma of the oesophagus death occurring 21 hours after operation. He made a crucial incision just below the xiphoid, grasped the stomach, incised it and inserted a specially devised silver cannula with which he proposed to hold the stomach in contact with the parietes. The stomach being under greater or pulled the cannula inside the abdominal cavity where it persisted in remaining. Feeding attempts were unsuccessful and some of the ingesta were found free in the abdominal cavity at autopsy. Sedillot (6) again attempted the procedure in 1853, attaching the stomach to the parietes with sutures. Five days later the stomach was opened with a bistoury, a tube inserted and feeding begun. Death occurred on the tenth day. He made no further attempt. Fenger (9) in 1854 through an incision (which bears his name) along the left subcostal margin attached the stomach to the margins of the tegumental wound, opened the viscus and sutured the mucosa to the skin. This suture of the mucosa to the skin is the chief feature in Terrier's operation done some years later. Death in Fenger's case occurred in 58 hours. The first attempt in America was made by Maury (21) in 1869, also with a fatal termination.

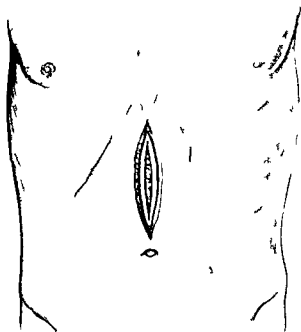


FIG. 1. The relative positions of the midline incision and the stabwound.

In 1875 Sydney Jones (17) obtained the first recovery after gastrostomy. This was the twenty-ninth attempt in 26 years following its inception and the third of Sydney Jones. The patient lived

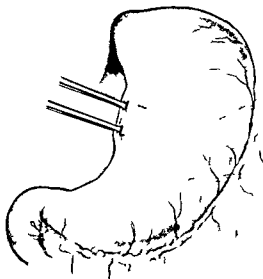


FIG. 2. The Allis clamp placed to outline the flap. The clamps at the base are indicated by the dotted lines as their use is optional.

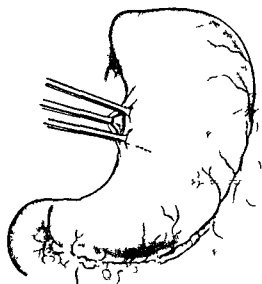


FIG. 3. The first incision for the raising of the flap has been made. A clamp has been placed at the center of the incision on the lesser curvature side to mark the site for the incision of the closing suture.

40 days succumbing from what appears to have been a perforation of the œsophagus by extension of the carcinoma and bronchopneumonia. In 1876 Verneuil (34) of Paris using Lister's antiseptic technique obtained the second recovery and in 1879 Petit (23) collected 41 cases with 7 recoveries a mortality of 83 per cent. Ashhurst (1) in 1893 in a series of 396 cases gives the mortality as 64.9 per cent. DeCosta gives the mortality in malignant cases as 20 to 25 per cent and in the non-malignant as 8 to 10 per cent. Our mortality has been 18 per cent in 17 cases.

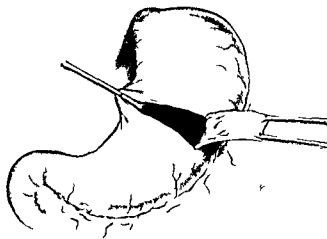


FIG. 4. The clamps have been removed and replaced to grasp the entire thickness of the cut edge of the stomach wall and the flap has been completely raised.

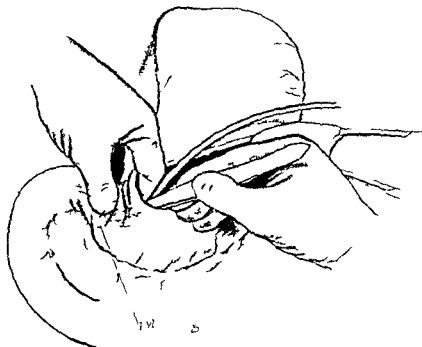


FIG. 5. Inserting the feeding tube through the pylorus into the duodenum.

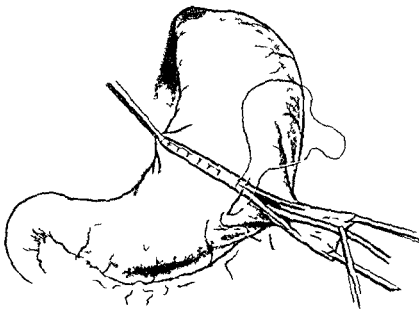


FIG. 6. The feeding tube has been inserted through the pylorus into the duodenum. The muscular layer is partially implanted.

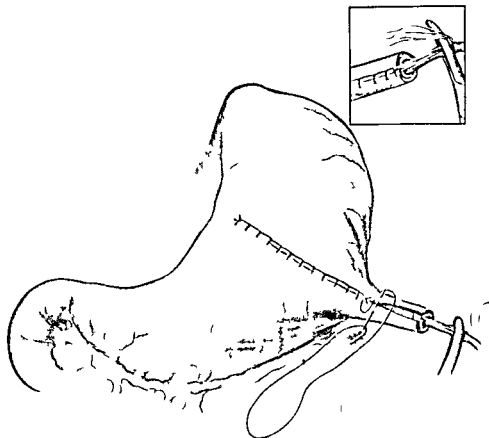
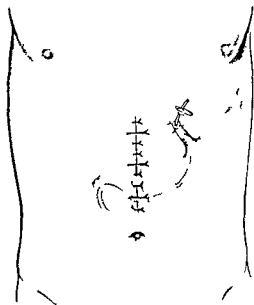
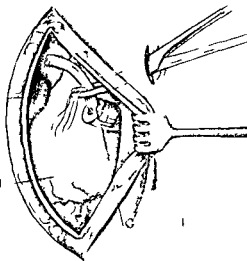


Fig. 7. Suture of the mucous layer has been completed and the end of the suture cut. The tube is secured to them by a clamp. Suture of the serosa is partially complete.

Perhaps no operation so clearly conceived and so relatively simple in performance has been attended by such disastrous results before its first successful execution. The surgical pioneers whose faith in its practicability was finally justified were supported in their repeated attempts by the conviction of the analogy between accidentally acquired fistula and those which they attempted to construct. They were all impressed by the fact that autopsies showed no local cause for death in the majority of cases and that the fatal terminations were due to delay in operation and the consequent extreme inanition of the patient. In an analysis of the first 41 cases so ably reported in detail by Petit one can not but be impressed by the practically moribund condition of the majority of the cases operated upon. In the few whose condition seemed a little less grave some random trick of fate brought on an early and unfortunate termination. We shall refer again to this most significant factor in mortality statistics as it applies to present day figures. Through all the literature one finds a constant plea for earlier operation by the surgeon and an implied lack of confidence in the procedure by the physician.

In the pre-antiseptic days any exploration of the abdomen was extremely hazardous and much discussion is found relative to the location of the incision so as to fall directly on the stomach. Jacobi (15) injected tartaric acid and then sodium bicarbonate through a stomach tube to distend the stomach with gas while Schoenborn (24) inflated a balloon after having inserted it into the stomach on the end of a stomach tube. It was feared that the transverse colon would be mistaken for the stomach which in these days of extended and bold exploration seems incredible. This uncertainty was due to a general lack of familiarity with the gross appearance of the several viscera. Wunder (20) in 1876 made an unsuccessful attempt and at autopsy found that he had opened the transverse colon. Considering the surgical era in which he lived one can more easily forgive his error than accept his justification of it for he complacently remarks that it makes little difference to him which viscus he opens, the principal object being to assuage thirst and that one can inject water into one as well as the other.

The successes of Sydney Jones and Verneuil aroused a new interest in the procedure and were



I 8 A l r l k lly lam h b t d
tl htl t l dt g p tl t l f tl ut d
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followed by more frequent and earlier attempts so that by 1884 Gross (12) was able to collect 207 cases. Until about the last decade of the 19th

century the surgeon seems to have been content with a simple direct fistula but its manifest disadvantages called for modification of the procedure. Between 1891 and 1896 five of the no-

classic methods were reported and a review of the subsequent literature reveals so numerous and such varied techniques and modifications that one is forced on this evidence alone to conclude that none is entirely satisfactory. The chief disadvantages common to most methods of gastrostomy are leakage with its attendant irritation and digestion of the skin, the discomfort of constant wearing of the tube and the early closure of the fistula following removal of the tube. We propose to mention only those methods which are or have been in common usage and those illustrative of some special technique. For convenience they may be divided into two general types.

In the first type, in order to prevent leakage there has been formed a long tract lined with granulation tissue leading from the skin surface to the stomach and an attempt made at the formation of a valve. Of this type the best known examples are the Witzel (36), the Stamm (29) (often confused with the Senn), the Marwedel (19) and the Kader (18). In the Witzel the rubber tube is buried

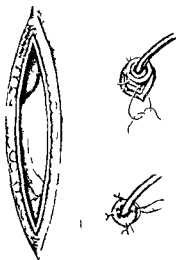


Fig. 9. The direct gastrostomy with a tube inserted through the skin and sutured to the skin.

und r folds of the outer wall of the stomach in the Marwedal tube is buried between the muscular and mucous coats and in the Stamm and Kader the stomach wall is invaginated about the tube by different techniques. But since in all these procedures the ultimate result is always simply a comparatively long tract lined by granulation tissue requiring the constant presence of a tube to prevent closure the valve cannot function and is superfluous. As their ultimate results are identical for all practical purposes there is in our opinion nothing to recommend any one of the above procedures over the others except its relative ease of performance and simplicity. Any merit that this type of operation may have is due to the long fistulous tract which offers a firm purchase on a constantly worn tightly fitting rubber tube which thereby prevents leakage. The persistence of an exposed and unhealed surface covered by granulation tissue subject to trauma infection and digestion by gastric juices is in itself an abhorrence from the standpoint of good surgery.

In the second type of operation the chief object has been to construct a fistulous tract entirely lined by epithelium unaffected by the digestive action of gastric juices and not requiring a constantly worn tube to prevent closure. Terrier (3) pulled a cone of stomach wall directly through the incision and sutured the mucosa to the skin. In the Ssabanajew Franck operation (10) a cone of stomach is pulled out of the wound and passed under a bridge of skin. Hartmann (14) and D. Agostino (5) led this cone of stomach obliquely through the rectus muscle and Hahn (15) up under and between the ribs in an effort to obtain a more efficient valve. E. Senn (8) pulled a cone of stomach through the abdominal wound and puckered it with two purse strings of catgut and a cuff of omentum about its base. This cone is sutured in the abdominal wound and the stomach depends for its continence upon the invagination of its edges which are supposed to function like venous valves. Stewart (30) and Beck () have utilized the skin of the abdomen to form a plastic tube which was led through the abdominal wall and sutured to the edges of an aperture in the stomach. Edwards (7) devised an ingenious method of constructing a tract lined by mucosa which lay between the coats of the stomach wall the outer portion of the fistula however being a wound through the abdominal wall as in the Witzel operation. Truel (31) used a section of jejunum attached to its blood supply to form a channel between the stomach and skin surface.

The Witzel Stamm Kader and Marwedal operations or their modifications are identical for

all practical purposes in their results namely the establishment of a long tract lined by granulation tissue. This tract requires the constant presence or frequent reinsertion of a tube to prevent closing. If the tube is constantly worn and fits snugly in the tract the presence of a valve is superfluous. Although the formation of a valve infers the removal of the tube except for feeding we have found that all operations of this type done by ourselves or by others (which we have followed) have been eventually forced for one or more reasons to leave the tube constantly in place (see also Keen). Should leakage occur it can usually be decreased or prevented by a tightly fitting tube constantly worn which is in effect the choice of the lesser of two evils. Reinserting the tube through the granulation lined tract subjects it to trauma and the possibility of its misdirection outside the tract especially as the tract tends to close. Should the tube not fit snugly so that leakage is marked digestion may occur not only of the skin but of the edges of the tract itself resulting eventually in a large incontinent fistula totally inefficient for feeding purposes and leading to a fatal termination from malnutrition and infection. In this type of operation the discomfort of constantly wearing the tube must be balanced against leakage probable eventual difficulty and danger in the frequent reinsertion of the tube as well as the inevitable closing of the fistula should the tube be left out entirely even for a few days. Certainly only the more intelligent patient can be trusted to maintain the patency of his fistula should his dysphagia temporarily improve. De page (6) reports a case in which after a Marwedal operation for carcinoma of the oesophagus there was a marked temporary improvement in the swallowing. The patient in spite of all frequently repeated advice to the contrary left the tube out entirely resulting in early closure of the fistula. As is the rule in this disease the dysphagia soon returned and a second operation was done under the difficulties of the scarring and adhesions of the first. The fistula was not continent and the case soon terminated fatally.

In the Ssabanajew Franck type of operation the fistula is entirely lined by gastric mucosa but comparative continence is difficult to obtain. If the formation of a valve is attempted by leading the cone of stomach wall by a more devious route through the abdominal wall or up under the tenth rib as in Hahn's operation a very serious amount of stomach wall is sacrificed thus tending to decrease the capacity of the stomach for the necessarily liquid and therefore less concentrated foods. Should the cardia of the stomach be

less than 2.5 centimeters apart as near the attachment of the gastrohepatic omentum as possible and parallel to it marking the free end of the flap. Two others are placed a little further apart about 6 centimeters directly opposite the first two toward the greater curvature and parallel to it marking the base of the flap. These clamps mark out an approximately rectangular portion of the anterior stomach wall. After doubly clamping the superficial blood vessels an incision is made between the lesser curvature and first two clamps quite near the latter and in a line with them entering the stomach cavity (Fig. 3). It is of advantage to cut first through the serosa only, grasp the mucosa and open it with a stab wound then complete its incision with scissors which will insure against displacement of the mucosa. When the incision has been completed to just beyond the first two clamps these are removed and replaced so that they grasp the entire thickness of the cut edge of stomach wall a procedure which further insures against displacement of the mucosa when the incisions at the sides of the flap are cut. Another clamp is placed at the middle of the first incision on the lesser curvature side. This is to mark the middle of the defect left by raising the flap and the point of beginning suture of closure of the defect. From the extremities of this incision two others are made at right angles toward the respective clamps near the greater curvature and evert the flap hemostasis is quickly effected (Fig. 4). At this time any free fluid which tends to escape from the stomach should be carefully sponged out. By the placing of one finger in the stomach directed toward the pylorus the pyloric sphincter can be located readily and by the manipulation with thumb from without it can be brought into view or even everted into the wound. It is relaxed by gentle manipulation with the finger and a soft rubber tube (25 centimeters long, 4 millimeters in diameter or a No. 1 French catheter) is inserted through it (Fig. 5) and passed down through the duodenum into the jejunum the free end being clamped to the free end of the flap. Kinking or curling up of this tube within the duodenum need not cause any uneasiness for we have found that it invariably straightens itself out within a few hours. We close the wound in the stomach (Figs. 6 and 7) beginning at the clamp which marks the middle of the first incision continuing up the edges of the flap enclosing the rubber tube and forming a gooseneck tube of the flap. The closure is effected by a continuous interlocked suture of No. 00 plain catgut of the mucosa only and a continuous interlocked Lembert suture of No. 00 chromic catgut of the serous

coat. Hemorrhage need not be feared as it already should have been carefully secured against by clamp and ligature. When the sutures are completed and tied at the distal end of the flap they are cut long and the rubber tube secured to them by a clamp.

A finger is placed on the peritoneal surface and a stab wound about 2 centimeters in length is made through the outer border of the left rectus just below the costal margin (Figs. 1, 8 and 9) proceeding through the rectus muscle in a zigzag manner so that a portion of the muscle fibers to the right of the wound are displaced to its left and vice versa. This will markedly increase the valve action. The cut edges of the anterior rectus sheath are now grasped with clamps. This is more easily done now than later. A large curved Kelly clamp is then inserted through this stab wound (Fig. 8) into the abdominal cavity to grasp the cut ends of the sutures and the rubber tube and by gentle traction from without and manipulation within the end of the gooseneck tube is brought out through the stab wound so that it projects slightly beyond the skin surface. It is fixed to the anterior rectus sheath (Fig. 9) by one stitch of No. 1 chromic catgut on either side placed through the sheath and its serous and muscular coats. The mucosa is sutured to the skin by four interrupted sutures of silk placed at the angles of the wound and at either side extending through skin and mucosa but not serosa or muscularis. The abdominal cavity is then inspected to insure proper position of the parts and the median incision closed in the conventional manner.

When the dressings are applied the rubber tube is made to extend directly through them all through an interval between the adhesive strips and through the tails of the Scultetus bandage so that feedings may be given without disturbing the dressings. The tube is fixed to the adhesive dressing by a safety pin or what is even better the tube may be encircled tightly by several turns of a narrow strip of adhesive and the pin inserted only through the adhesive. Leakage may be prevented by folding the end of the tube on itself or by plugging its end.

Feeding is begun as soon as the patient returns to the ward. Three ounces of peptonized milk are introduced every 3 hours on the day of operation and the amount increased to 4 ounces every 3 hours the day following operation. 5 ounces on the next day and so on until there is definite discomfort after a feeding indicating that the capacity of the stomach has been reached. A distressed feeling usually occurs when about 12 or 14 ounces have been introduced although after a time a full pint

can be taken without discomfort. When this amount is reached the interval between feedings may be increased to 4 hours. Saline should be given by rectum and subcutaneously for the first few days if there is even moderate dehydration.

The tube is shortened about an inch each day until the sixth day when it is removed entirely and inserted for feeding only. When the tube is entirely removed and reinserted so that food is placed directly in the stomach eggs sugar butter or any food capable of solution or fine suspension is added until the combined 4 hour feedings total well over 2500 calories. The caloric value of the daily feeding should be carefully calculated in all cases and under no circumstance should the diet be left to the whim or caprice of the patient. An accurate calculation of an estimated diet will never fail to convince the surgeon as to the reason for failure to gain in weight. The patient may be gotten out of bed whenever it is felt that the mid line incision has healed firmly.

We have been troubled with leakage in only about 5 per cent of cases. These were due to the use of a too wide stomach flap and consequently a gooseneck tube of a too large diameter. The flap should be just wide enough to fit snugly about the rubber tube which should not be larger than a No. 16 French catheter. In this type of operation the continence of the fistula is due both to the collapse of the narrow channel and to the constricting action of the displaced fibers of the rectus muscle.

As all gastrostomy feedings must be liquid there is nothing to be gained by the use of a large tube except rapidity in feeding. Rapid feeding often causes *uneasiness and a sense of distention* or nausea quite out of proportion to the amount given. A large tube will also distend the fistula which in itself favors leakage as the tube is with drawn. Under no circumstance should a feeding tube larger than a No. 16 French catheter be used and a smaller one will usually suffice. A small tube is sufficient safeguard against too rapid feeding. Feedings may be conveniently given either by a funnel and allowed to enter the stomach by gravity or by the use of a rubber bulb syringe.

The procedure is accompanied by no more surgical shock than is any other type of gastrostomy. The wound edges should be well protected against gross soiling by stomach content which is very apt to be teeming with saprophytic bacteria if there has been slow seepage of decomposed food through an ulcerated stricture of the oesophagus.

The only marked difference in technique between this operation and the Ssabanajew-Franck is the construction of the plastic tube which adds

only about 15 minutes to the total. A fair time for the entire procedure from the beginning of the local anesthetic is 45 minutes.

In several cases we have used Depage's method cutting the flap with its base at the lesser curvature. At first glance this method would seem the most logical for the fistula would then leave the stomach at a higher level. If furthermore the gooseneck were brought out near the xyphoid it would seem that continence would be further favored by its upward direction. But we have found that continence depends more on the small diameter of the fistula and to the sphincter like action of the rectus than to the direction of the tract. In the Janeway method the direction of the tract is also slightly upward. If Depage's plastic tube is brought out through the left rectus both the tube and the comparatively inelastic gastro-hepatic omentum are placed under considerable tension and the tract assumes a rather downward direction. Therefore in using Depage's technique we have made a left rectus incision and brought the gooseneck tube out through a stab wound near the xyphoid. By so doing we substitute the rigid inelasticity of the fascia of the midline for the yielding sphincter like action of the rectus. Leakage has been greater than in Janeway's method. In either method the gooseneck should be brought out through a stab wound rather than through the upper angle of the operative wound and the stab wound should be only large enough to fit snugly about the gooseneck.

Insertion of the tube into the jejunum first suggested by Petit in 1879 (3 p. 107) permits immediate feeding and prevents any distention of the stomach until healing takes place. No other type of operation so readily admits repeated retrograde oesophagography, retrograde boulinage, gastroscopy or pyloroscopy. By the passing of successively larger bougies through the fistula for 10 or 15 minutes any ordinary sized instrument can be inserted. If boulinage or radium therapy is intended a retrograde bougie may be passed at the time of operation. The bougie is passed through the stomach up through the oesophagus and out the mouth drawing a thread with it. This thread is left to emerge through the mouth and the stoma of the gastrostomy alongside the rubber tube and will serve as a guide for instrumentation or placement of radium at any time after the first week or 10 days.

Should the necessity for gastrostomy feeding be obviated for any reason no fear need be entertained for the patency of the fistula. We have had one case in which all feedings were taken through the mouth for 6 months. Dysphagia is a common super

vened and the patient came to the hospital in a starving and dehydrated condition. The skin had healed about the stomach leaving a sinus about millimeters in diameter. With a closed blunt forceps this sinus was quickly dilated a feeding tube readily inserted through the fistula and feed was immediately given.

We have examined the stomachs of many of our cases dead of malignant disease after this operation and have found no evidence of any contraction or deformity. The fact that most patients will take 16 ounces at each feeding seems sufficient evidence that there is little decrease in stomach capacity. We have repeatedly and successfully performed the operation in the presence of marked neoplastic involvement of the cardia.

In this operation the disadvantages of the other types are largely overcome namely leakage and its sequelae the discomfort of a tube constantly worn and the danger of closure of the fistula. In short it combines all the advantages attempted in other types a fistulous tract lined by epithelium not subject to gastric digestion or infection a continent and permanent fistula and a stomach with a minimum deformity with a minimum decrease in capacity and gastric mucosa available for digestion.

Gastrostomy is indicated in persistent dysphagia from whatever cause in cases in which complete relief can not be anticipated within a comparatively short time. This would seem to imply that the operation should be done for carcinoma of the esophagus as soon as the diagnosis can be made which is exactly what we advocate. Carcinoma of the esophagus has up to this time resisted all methods of treatment except operative excision in operation which has an incidence of mortality among the highest of operative procedures. Gastrostomy is imperative before aggressive radiation for in such case a temporary increase in dysphagia is the rule. In carcinoma of the esophagus the patient is under a double hazard. The disease is always fatal. Death will occur from perforation if alimentation is sufficient to support him until that eventuality occurs how ever without gastrostomy death from starvation and water deprivation practically always precedes perforation. The best palliative treatment of the disease then is one which will prevent death from starvation and defer perforation longer than would otherwise be possible. Gastrostomy does exactly this and offers the patient a few months or even several years of comparative comfort. There is often a temporary improvement in the dysphagia after gastrostomy due to decrease in inflammation and swelling about the stricture. The removal of

swallowing as a cause of irritation undoubtedly delays extension of the disease into the mediastinum trachea or neighboring blood vessels and lessens the chance of metastasis. We do not advocate the insertion of cannulas (Myerson and others) for the reason that the presence of a foreign body in the neoplastic stricture will certainly hasten extension of the disease and perforation. We are opposed to repeated dilatation of a cancerous stricture for the same reason. We have had a case of carcinoma of the esophagus live 4 years after operation in comparative comfort. A gain of 40 to 50 pounds in weight is not uncommon and many patients return for a period to their regular occupations. A recent case returned to his trade as harness maker about three months after operation. For the last 7 months he has lost no time from his occupation except to return to the clinic at regular intervals for observation. It should be noted that this patient has gained about 5 pounds and takes a measured and calculated diet of about 3500 calories.

In benign stricture of the esophagus gastrostomy is indicated only when progress of dilatation of the stricture is difficult and improvement of the dysphagia is at a standstill for a definite period.

The postoperative mortality of gastrostomy should be no higher than that of any operation of equal gravity certainly less than in gastroenterostomy for in the latter deeper exploration and more extended handling of the viscera is required. The mortality of gastrostomy depends not so much on the technique employed or on the unusual skill of the operator as on the condition of the patient. The drop in mortality from 83 per cent in 1879 as reported by Petit to about 5 per cent today is undoubtedly due largely to earlier operation and consequently to a more favorable condition of the patient. If every case of dysphagia could be promptly investigated and the indications for gastrostomy appreciated by the physician the mortality of this operation would be negligible. Comparative statistics indicate the degree of inanition of the patient rather than the relative value of any method or the skill of any operator. Although our statistics compare favorably with other observers we do not advance this as an argument for the method we employ but will rest its merits on the comparative comfort of the patient on the length of life and on the near approach of the Janeway method to the ideal gastrostomy which we have outlined.

We repeat again that gastrostomy should always be done as soon as the diagnosis of carcinoma of the esophagus is made and before there is marked loss of weight. The X ray usually suffices to make

the diagnosis although it can be definitely proved by œsophagoscopy. It should also be done quite early in a benign stricture resistant to treatment. We have had two cases of persistent cardiospasm in which the operation undoubtedly saved life until the condition could be otherwise relieved.

SUMMARY

1. A consideration of the most common method of gastrostomy reveals that they are subject to one or more of the following disadvantages: leakage and its sequelæ, the necessity of a constantly worn tube or difficulty and danger in its reinsertion, closure of the fistulous tract should the tube be left out and relative difficulty of instrumentation through the fistula.

2. A method is presented which is a modified and improved technique first reported by Janeway in 1914.

3. The Janeway method overcomes the disadvantages of gastrostomy more satisfactorily than any other method yet devised.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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EDUCATION PAYS

AS one travels about the country one is impressed by the splendid public school buildings seen in all sections. Often in poorly developed territory with few evidences of prosperity there is to be found situated on the highest point of land in the vicinity a fine public school building a source of pride to the inhabitants and regarded by them as a hostage for the future. Apparently there is an unconscious feeling that if we are to have the government we like and prosperity for all it must be through education. Every thoughtful man must wonder at times whether this education which has become almost a religion will adequately measure up to the hopes of the common people of the country.

The older generation is always uncertain about the younger generation. In the earlier time young people were kept innocent with the expectation that innocence would be a protection to their morals and ethics. The young people are more sophisticated today and perhaps because they know more of evil they will be better protected from it than they would had the innocence of past generations been maintained. In the days of my

youth the lady swept the filthy streets with her skirts. The short skirts of today are at least more sanitary.

The common man the average citizen in intellectually forms 50 per cent of the population. About 15 per cent of the population are above the average in intelligence. In this 15 per cent unfortunately there are with the sound thinkers the froth the pink socialists and the near philanthropists citizens who make gestures but who fail to follow them up by good deeds and who are as a group unorganizable. The 35 per cent below the average in intelligence are in the boy scout stage mentally and unfortunately are too readily organizable. The demagogue more effectively appeals to their prejudices than the statesman does to their mentality. The social and economic burden of the common man is a heavy one he is truly the backbone of the country.

It is easy to philosophize the philosopher is said to be one who bears with equanimity the sufferings of others. These remarks are made as a prelude to the corollary that education does pay.

Members of the Legislature of the State of Minnesota. I say with all the pride natural to a native of the state are above the average in intelligence. The material resources of Minnesota are largely agricultural mining and industrial and the legislators of the state are representative of these fields. In the session of the Legislature before the last to our surprise the term for bringing malpractice suits was shortened from six years to two years and many improvements in the Medical Practice Act of the state were passed without

difficulty During the last session of the Legislature under the leadership of an active legislative committee headed by a former president of the Minnesota State Medical Association Dr Herman M John on a basic science medical bill which provides that those who practice medicine in the future must have sound fundamental education in physiology anatomy and the basic sciences was passed by a vote of 61 to 1 in the Senate and 111 to 7 in the House An antivivisection bill was defeated in committee without effort there is reason to believe that had it come to vote not to exceed five votes would have been cast in its favor The bill for military training in the University of Minnesota which had been stoutly assailed by the pacifists was reaffirmed by legislative enactment by a 4 to 1 vote and lastly the boot leg theology of the anti evolutionist was turned down almost unanimously by an exasperated legislature Even ten years ago I believe our legislators would not have dealt so intelligently with the arguments presented during the last session

W J Mayo

TUBO-OVARIAN DISEASE

THE fact that much of the surgical literature of the past few years has dealt with lesions in the upper abdomen has at this time offered an opportunity for a short discourse on tubo ovarian infection

Over 90 per cent of all tubo ovarian infections are due to the gonococcus however some few cases result from either puerperal infection or the improper use of the curette Gonorrheal infection of the tubes is usually bilateral condition The tubes become closed early while in tuberculosis they remain open They will be only slightly congested and oedematous throughout the entire coats in the early stage and later the infection reaches the fimbriae when it causes the tubes to close and

form a pocket of pus Occasionally the pus will escape into the abdominal cavity and cause a general peritonitis Frequently after the tubes become closed and a pus pocket has formed the fimbriae become attached to the ovary and a destructive infection is caused As a result of the peritoneal inflammation the infected tubes and ovaries and the heavy uterus drop low down under the broad ligaments and form a conglomerate mass called a tubo ovarian abscess This mass is usually fixed to the uterus and pelvic floor and covered over by omentum and intestines

The diagnosis is made from the history of urinary frequency with burning and stinging the characteristic yellow discharge the occasional finding of gonococci in a vaginal smear and from the finding of a fixed uterus or mass in the pelvis either alone or as associated with a fibroid uterus In some of the longstanding cases a diagnosis of typhoid fever tuberculosis or malaria might be made should the physician not happen to make a vaginal examination

In acute salpingitis some few cases will clear up by rest in bed douches and expectant treatment but the majority will have evidences later of a chronic pelvic infection In view of the fact that some few cases entirely recover one must treat conservatively at the initial illness but if there has been a history of previous attacks or a fixed uterus or a mass felt we have no hesitancy in operating during an acute exacerbation This is done for two reasons first the mortality rate is no higher in our experience than that following operation during an interval as these patients though extremely sick stand operation well second the average person is not able financially to remain in a hospital very long

There are a few points which we would like to mention regarding the treatment of these cases

1 In operation for tubo ovarian disease due to gonorrhœal infection a definite line of cleavage may be followed in the separation of the structures while in cases due to puerperal infection no cleavage is evident because the infection is systemic with no tendency for localization

To obtain the best results it is absolutely necessary to do a complete removal of all infected organs for if not future trouble will necessitate secondary operations. When the ovaries are infected and destroyed conservative surgery leads to later operations. The symptoms of nervousness that follow are not severe but in fact slight as compared with those following the removal of the ovaries for other conditions. It is of particular interest to know that the negro does not suffer from any nervous discomforts after bilateral oophorectomy.

3 The uterus rarely needs to be removed unless it contains fibroids or one or more abscesses because it will usually return to its normal size after the removal of the infection. Uterine bleeding which occasionally is seen in cases of pelvic infection will stop after the removal of the diseased tube the ovary or both.

4 Though they are extremely sick and are being subjected to operation during an acute attack these patients stand operation well and even better than they could for almost any other abdominal condition.

5 It is absolutely necessary to make a thorough examination of the structures in the lower abdomen to separate adhesions and to examine the intestines (especially the lower ileum) as this will lessen postoperative obstruction.

6 In an occasional chronic case drainage will not be necessary but as a rule drainage with gauze by which means the intestines can be packed off from the true pelvis will afford the best ultimate results and a minimum of postoperative complications.

In the South where a great deal of surgery is done among the negro race more operations are performed for tubo ovarian disease of the child bearing negro woman than for all other conditions combined. In this race of people a case of primary appendicitis is not common for in most cases gonorrhœal infection is the primary cause for surgery and the appendix secondary. Many of these people are also infected with syphilis but this is no barrier to surgery in the pelvis.

HUGH S. BLACK

MASTER SURGEONS OF AMERICA

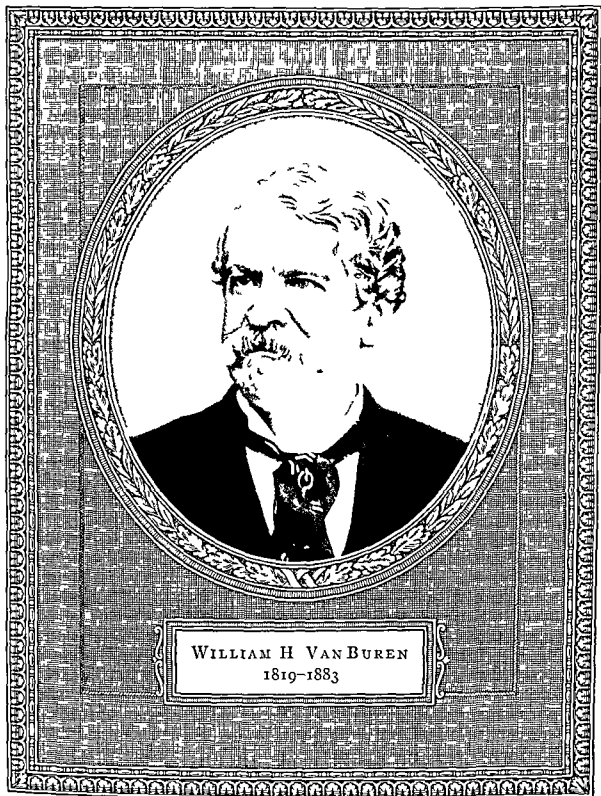
WILLIAM HOLME VAN BUREN

FEW men in this country have known so much about the surgery of their time as did Samuel D. Gross of Philadelphia and above all few were in a position such as he was to estimate the distinction reached by their contemporaries in American surgical life. In the diary published in connection with his autobiography Gross has this entry under the date of March 25 1883. This ought to be a sad day for me. One of our most distinguished men has dropped out of our ranks. Van Buren died this morning at his house after a protracted illness. The opinion thus freely expressed by Gross was shared by all those in this country who were in a position to know the work and the character of Van Buren.

In writing the *History of Medicine in New York* (New York 1919) I came to realize that Dr. Van Buren had to be given a place of honor among the greatest of the men who in our Empire State have devoted themselves to the creation of a surgical specialty. His textbook was known not alone in this country but throughout the English speaking world and his name was known everywhere in the medical world of his day.

Van Buren's education was interesting. He was expelled from Yale for what surely must have been a school boy prank for he then spent 2 years studying medicine in the University of Pennsylvania and was ready for graduation but had not reached the age of twenty one at which graduation was permitted. He therefore went to Paris to fill in the time. There he was a member of the house staff of La Charité under Velpeau who was considered the greatest surgeon of his time. Van Buren had to work hard but merited and received the approbation of his chief. In the clinic he met Valentine Mott the well known New York surgeon who was in Paris picking up what was latest in surgery. Van Buren returned to New York to become the assistant and then the son in law of Mott.

He received his degree of doctor of medicine at the University of Pennsylvania his thesis being the starch and dextrin bandage which he had seen used so successfully in Paris. This initiated the treatment of fracture by immovable apparatus. The value of Van Buren's essay was recognized by the faculty who secured its publication and afforded its author the opportunity for a public demonstration. This attracted wide attention and toward the end of his life Van Buren used to



WILLIAM H VAN BUREN
1819-1883

say that the audience which assembled to see him apply his bandages was the largest professional gathering before which he ever appeared. After this he was a marked man in the profession.

Van Buren took the competitive examination for entrance into the army medical service and passed first ahead of men who afterward became surgeon generals of the United States. He served for some 5 years in the army and then contracted a severe malaria which undermined his constitution and probably shortened his life. He returned to New York, married Dr. Mott's daughter and soon was professor of anatomy in the medical school of the University of New York, became very prominent in the medical teaching and professional life of New York City. During the Civil War President Lincoln offered to make Van Buren surgeon general and when for excellent reasons he refused, the President insisted on having him name the candidate he deemed most suitable for the position. No wonder that alma mater Yale made up for step motherliness earlier by conferring an honorary degree on him.

At the end of the Civil War Van Buren was selected as professor of the principles of surgery in Bellevue Hospital Medical College at that time one of the leading medical schools in the country. He occupied this position for some 16 years until his death in the early eighties, but he became known particularly for his clinics in the surgery of the genito urinary organs. His father in law, Valentine Mott, had become famous as a lithotomist. Genito urinary operations occupied the place then that abdominal operations usurped afterward. In those days it was men rather than women who had to undergo the majority of serious surgical operations.

After many years of special study of the subject Van Buren in conjunction with Edward L. Keyes wrote an exhaustive treatise on *The Diseases of the Genito Urinary Organs*. This was issued in edition after edition for years and was considered the best authority on the subject in this country. It gave Van Buren a reputation abroad and since he had made some of his studies in Paris it was received with favor by the French who were at that time the leaders in the specialty. Until his researches in the matter the genito urinary diseases had been made entirely too little of. Our present recognition of their significance dates from this publication.

Besides the textbook in which he collaborated with Keyes Van Buren published a volume of some two hundred pages on surgical cases. He called it *Contributions to Practical Surgery* and the volume would remind one in many ways of the clinical lectures so popular in our day. The book illustrates very well what an excellent teacher Van Buren must have been and makes it very easy to understand why his students thought so much of him. He did not limit his work entirely to genito urinary surgery for he published a small volume of *Lectures on Diseases of the Rectum* which had been delivered at Bellevue Hospital Medical

College in 1870 and published by Appleton that year. The annotated copy that I have had before me while writing this sketch shows that he was preparing to issue another edition of it not long before his death. It is a valuable practical manual of the treatment of diseases of the lower bowel.

In the memorial address read before the New York Academy of Medicine April 5, 1883, of which body Van Buren had been vice president Edward L. Keyes, who as I have said had been associated with Van Buren for many years, did not hesitate to say that his death at the comparatively early age of 63 years

terminated a career of no ordinary brilliancy and left a place in the ranks of the medical profession which will probably long remain unfilled. To Van Buren and his father-in-law, Valentine Mott, New York owes more than to any others its prestige in the teaching of medicine which developed just before and after the middle of the nineteenth century. As Keyes said, Dr. Van Buren left behind him a reputation surpassed by no one for high refinement as a gentleman, classical polish as a scholar, unequalled grace as an operator, clearness, force, elegance as a teacher, profound judgment as a physician. He has left his mark upon the profession he adorned and has elevated its tone and its dignity by his uncompromising exaction of respect for the science and art in which he dealt—a respect which he insisted upon from all who approached him in the consulting room or elsewhere.

JAMES J. WALSH

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In the memorial address read before the New York Academy April 5, 1883, of which body Van Buren had been vice president Keyes, who as I have said had been associated with Van Buren for did not he state to say that his death at the comparatively early age terminated a career of no ordinary brilliancy and left a place in the medical profession which will probably long remain unfilled. To Van Buren's father-in-law, Valentine Mott, New York owes more than to any other man the prestige in the teaching of medicine which developed just before the middle of the nineteenth century. As Keyes said, Dr. Van Buren had a reputation surpassed by no one for high refinement as a gentleman, polished as a scholar, unequalled grace as an operator, clearness as a teacher, profound judgment as a physician. He has left his mansion he adorned and has elevated its tone and its dignity by his commanding exaction of respect for the science and art in which he was engaged, which he insisted upon from all who approached him in the consulting room elsewhere.

THE SURGEON'S LIBRARY

OLD MASTRPIECES IN SURGERY

By ALFRED BROWN M.D. F.R.C.S. OXFORD

THE SURGERY OF GABRIEL FALLOPPIUS

PADUA calls to mind the period when the surgery of the sixteenth century was making its brave attempt to escape from the toils of the Galenic ideas and to gain the heights of sounder knowledge based on the anatomy of the human instead of the animal body. Padua lays claim to being the oldest city in northern Italy and its inhabitants claim descent from the fabulous Trojan Antenor. However chimerical these claims may be the city through its university crooned the cradle song not only of infant medical science but also of art and poetry and other sciences for in its roster we find the names of Giotto and Donatello the artists Bembé and Tasso the poets and Galileo the great astronomer. The names in the roster of brilliant medical men are legion for the fame of the Paduan school drew them nearly all to its walls. When Frederick II overthrew the Lombard rule and established his vicar to rule over Padua in 1136 he immediately set about founding the university completing the task in 1238. From this date on though there was constant warfare and restlessness the University survived and when the city finally passed under Venetian rule in 1405 the opportunity came for advancement in the arts and sciences. The arts came first and it was not until the early sixteenth century that medical science came into its own.

Though Padua and its university call to mind the names of its alpha and omega Vesalius and Harvey there are many others and among them not the least was Gabriel Falloppius who was born in Modena in 1523 nine years later than his famous contemporary Vesalius under whom he probably studied after he had completed his preliminary education with Antonio Musa Braccavola in Ferrara. He became in turn professor of anatomy at Ferrara and Pisa and finally in 1551 at the age of twenty eight was appointed professor of anatomy surgery and botany at the University of Padua holding the position until his death in 1562 at the age of only 39 years.

Though we know Falloppius best as an anatomist he was also professor of surgery at the University and his reputation as a practicing surgeon spread beyond the confines of his native land to both France and Greece. With his full life and many duties it is not surprising that only one of

his works the *Observationes Anatomicae* was published during his lifetime in 1561 at Venice and again in other cities in 1562. There are however many works which pass under his name which were issued posthumously but in only one is the word surgery used in the title. Apparently wounds only were considered true surgical conditions for in this work which treats of that subject alone the title reads. The very lucid interpretation of the famous Philosopher and Physician Gabriel Falloppius of Modena concerning that part of medicine which is called surgery including also wounds of the head from the book of Hippocrates now for the first time corrected and augmented with various discussions some medical some surgical and particularly the consideration of those affections which arise from wounds and their cure. Second Edition with Privilege Venice. At the house of the brothers Paulus and Antonius Meietus Booksellers of Padua 1571.

Falloppius must have been a remarkable teacher for above all things else the book demonstrates his ability to place his material before his hearers in a clear and logical sequence. Beginning with the things that must be known in order to treat wounds properly he states the definition concurred in by all authors that a wound is a solution in continuity. From that point he proceeds to a classification of wounds their symptoms prognosis and the various signs of healing. He is dealing one should bear in mind with a comparatively new type of wound in the gunshot wound. Consequently his discussion of the removal or failing removal the inclusion of foreign bodies is interesting. He advises removal but states that foreign bodies may in some cases remain without particular harm. In discussing wounds of deeper organs he differs from the ancient authors in holding that wounds of the eye are not necessarily fatal and in support of this contention cites not only his own experience but also that of Guy de Chauliac. His description of healing by primary and secondary intention is lucidly and simply expressed and we gather that his students had a clear idea of Falloppius' opinions at least at the end of their course of lectures.

When we remember that this man hailed by some historians as a greater anatomist than Vesalius at an age of less than 40 years had a grasp of the literature of his predecessors such as he demonstrates in this volume we marvel at his efficiency and ability.

REVIEWS OF NEW BOOKS

ANY product of the pen of Becclere dean of French roentgenology will be found to be worthwhile. The volume on radiology¹ just published covers the present day knowledge in the X ray field of interpretation of medical and surgical conditions. The illustrations in any work on the subject of X ray diagnosis are of even greater importance than they are in almost any other branch of medical endeavor. In producing this book the authors and bookmakers have rendered a distinct service by the excellent quality of the illustrations. Few works on this subject equal it in this respect. Occasionally a cut is found upside down having escaped the editor's eye. No practical application of X ray has been omitted and the subject matter covers the most recent developments such as the opaque filling of the respiratory tract, the gall bladder visualization and other similar procedures. Its five hundred odd pages are filled with material that anyone conversant with the French language will find informative as well as authoritative on the subject of diagnostic roentgenology. The authors announce the preparation of a second volume which will treat the subject of radiation therapy thus offering a complete work on the subject.

EDWARD S. BLAU

PYELOSCOPY consists in the radioscopic examination of the kidney pelvis which has been made visible by the injection of opaque solution. *La Pyelocope* deals entirely with a detailed description of technique and indications, contraindications and diagnostic advantages of pyeloscopy (fluoroscopic examination of the renal pelvis and ureter). The method is not intended to replace pyelography but has been used routinely in conjunction with it. The authors believe pyeloscopy yields diagnostic and prognostic data which can be attained in no other way. The methods advocated are painful in that the renal pelvis is filled with thirty per cent sodium iodide solution on the plates made and the subsequent contractions of the pelvis and ureter are fluoroscopically observed until the pelvis and ureter are completely emptied. Two hundred and four diagrams are presented to illustrate the diagnostic points which are stressed in the text.

While the subject matter is in French all of the plates are explained with captions in English, Italian, Spanish and German as well. Normal evacuation, pelvic retention in various forms of hydro-nephrosis, ureteral and pelvic calculi, movable kidney

neoplasms of the kidney and renal and ureteral anomalies are discussed in the order named.

VINCENT J. O'CONNOR

THE ground work of this monograph on the Thomas splint¹ is the work of the late Hugh Owen Thomas and more particularly the principles of his knee joint splint. The British mortality from shock in cases of compound fracture of the femur was reduced from 80 per cent in 1916 to 15.6 per cent in 1917 chiefly as the result of the immobilization secured by the early application and the use of the Thomas splint.

The author has considered every detail of the apparatus which is described from the standpoint of efficiency and comfort. The accuracy of the adjustment of deformity and the action of mechanical devices designed to lessen the burden of suffering were important factors in obtaining good results and in maintaining the morale of the soldiers. In the preliminary consideration the author gives a concise account of these important factors in the consideration of fractures. He describes the position of election for kylosis of the various important joints. First aid treatment is given in detail. The methods used to secure alignment, traction and immobilization are those so successfully used by the author during the late war. The application of the Thomas knee splints to fracture of the lower extremity is given in great detail and is illustrated by excellent photographs. Fractures of the bone of the upper extremities are considered and the various types are illustrated. There is a chapter on the wounds of the soft tissues. The author emphasizes the importance of careful study of good roentgen ray film.

In the appendix the specification of the Thomas knee splint are given in great detail as are the author's splint boxes for the arm and leg. Method for applying Sincal's glue or gelatin are given and there is an elaborate table of material required in the treatment of various fractures. The subject is very well handled and the illustration is on the whole excellent. It is a book to be recommended to every one doing industrial or traumatic surgery.

PHILIP L. WILKINSON

DEDICATED to Dr Adolf Meyer this new *Textbook of Psychiatry*¹ by two British writers aims to emphasize the biological viewpoint of the American school of psychiatry. This involves what might be called the longitudinal method of studying certain cases whose mental illness are regarded as the

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cumulative results of unhealthy reactions of the individual mind to its environment. The successful tracing of the factors which have led to unhealthy reactions often permits of their elimination in future and thus brings a definite improvement in adjustment. If this improvement is sufficient the result is a cure.

Mental illness is an individual affair. As no two lives are just alike, so no two psychoses are equal. Clinical records have been used extensively to help to the understanding of individual cases as human beings.

Beginning with a very interesting historical review of psychiatric work, the authors next consider the ever present problem of classification. Their suggested scheme appears to be an improvement on the many so far offered and uses only 8 main groups as follows: (1) affective reaction types, (2) schizophrenic reaction types, (3) paranoiac and paranoid reaction types, (4) organic reaction types, (5) epilepsy, (6) mental deficiency, (7) psychoneuroses, (8) unclassified.

Under general psychopathology and in the chapter on psychoneuroses the strong influence of Freud is evident. Instincts are primary data being given

in the innate equipment of the organism. There are probably only two, nutrition and sex. The following illustrates a healthy conservatism and careful tone. Strictly speaking, unconscious feelings, emotions, wishes and ideas are a contradiction in terms. But particular aspects of the instincts of which feeling etc. are the conscious representations can persist in an unconscious form. The term unconscious is itself a bad one since it defines something in terms of what it is not. The authors frequently do not hesitate to disagree with Freud on certain disputed points.

Following the excellent discussions of the principal psychoses which are well illustrated with case histories, the book concludes with chapters on psychiatric problems in war and in occupational therapy, including the legal aspects of psychiatry. The last, applying to England and Scotland, is not of great practical interest to the American reader.

The book is of medium size, excellently made and is a most welcome addition to the literature. It will be particularly pleasing to those not expert in psychiatry who desire something briefer than the large texts but equally sound.

JOHN FAVILL

CORRESPONDENCE

CONCERNING THE PREVALENT DENIAL OF FUNCTIONS LONG ATTRIBUTED TO THE GALL BLADDER

To the Editor—My attention has been called to the fact that my failure to cite the early work of Whitaker and his associates might be construed as a lack of appreciation of the importance of their contribution in first demonstrating the response of the human gall bladder to the ingestion of food. In two of my earlier publications this work of Whitaker was referred to at length (*The Anatomical Record*, 19: 5-1926). To those interested in reading the first description of the reaction of the human gall bladder to

food, I would suggest that in addition to the articles quoted in my paper in the January 1928 issue of *SURGERY, GYNECOLOGY AND OBSTETRICS*, they read the four articles of Whitaker and his associates published in the same journal in May and June of 1926, the *American Journal of Roentgenology*, December 1925, and the *Journal of the American Medical Association*, January 23, 1926.

EDWARD A. BOYDEN, M.D.

Chicago, Illinois

AMERICAN COLLEGE OF SURGEONS

1928 CLINICAL CONGRESS IN BOSTON

THE thirty-ninth annual Clinical Congress of the American College of Surgeons will be held in Boston the second week in October beginning Monday, October 8, continuing until Friday, October 12. Headquarters will be established at the Statler and Imperial Hotel. At the Statler Hotel the large ballroom and adjacent floor the College and other large rooms on the main floor will be used for registration and ticket distribution. Ballrooms, executive offices, exhibit tent, ballroom at the Copley Plaza will be used for the various scientific meetings with the exception of the Presidential Meeting on Monday evening and the convention on Friday evening which will be held in Symphony Hall.

The local program has been arranged by the committee with a full line and demonstrations at the following institutions: Harvard University, Boston University and Tufts College, Massachusetts General Hospital, the following hospitals: Beth Israel, Boston City, Boston Dispensary, Boston Lying-in, Peter Bent Brigham, Robert Brigham, Children's, Curran, Children's, Deaconess, Faulkner, Free Hospital for Women, Huntington Memorial, Long Island, Massachusetts Eye and Ear Infirmary, Massachusetts General, Massachusetts Homeopathic, New Eng-

land Baptist, New England Hospital for Women and Children, and St. Elizabeth's.

A committee on arrangements has been organized which includes the following:

Ed J C	Ott J H m n
Ch J C M t	Dan I F J s
S J	W E L dd
J h D A J ms	T ank H L h v
N th I M l	H l y L d
F ank n C F l h	I d B I nd
M l S B k	K H M l r
J F m B n h	W J M t
D d Ch	W I M h
A tl F C t	D l M o
J H Cu Ch m	I kl S N well
H r v C h	I B O d
J l D	W l m C Q by
H l l D	C I Sculdc
C S D b	J h L St to
W D k n	A W St ms
A W D ll	J m W St
l l l l	I n g T s
l l l l l h t	H l d W k
W l l c	W y m W l t m e
l l l c gh	H Z

The hotel situation in Boston has been greatly improved since the last session of the Clinical Congress in October 1926 by the building of new hotels and the enlargement of some of the older houses. There are now ample first class hotel accommodations in Boston for all who will attend

SURGERY, GYNECOLOGY AND OBSTETRICS

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NUMBER

SARCOMATOUS TUMORS OF THE TESTICLE¹

By HAROLD DFW FRCS FACS MELBOURNE AUSTRALIA
S E I O P T I M B H P I I

IN a recent monograph (13) I emphasized the confusion that had existed for many years with regard to the nature of round cell tumors of the testicle. For long it was stated in many textbooks that sarcoma was the commonest tumor of this organ and that it was a peculiar exception to sarcomatous tumors in general in that it produced metastases in the lymphatic glands. As pathological observations accumulated and these tumors were studied in greater detail it was found that many testicular tumors were in reality teratomatous in nature. The pioneer work of Wilms (49) Pick (39) Chevassu (7) and Nicholson (36) among others showed that about 50 per cent of these tumors contained derivatives of one or all of the three primary germinal layers although derivatives of any one of these layers could grow in excess and produce what at first glance seemed to be a homogeneous tumor. Another important fact was recognized, i.e. that any of the derivatives could undergo malignant change with the production of a carcinoma or a sarcoma, the development of a carcinoma from the hypoblastic elements being most frequently seen. Various writers including Waldeyer (47) Breus (4) Malassez (30) Carnot and Marie (5) had described peculiar testicular tumors which characteristically showed invasion of the veins with the formation of an intracapsular growth, some

sarcome angioplastique. Wlassow (50) and Schlagenhafer (43) first pointed out the well recognized fact that these are in reality carcinoma, the majority being chorionic type.

The other common tumors of the testis are soft homogeneous growths resembling sarcomata both microscopically and macroscopically and on account of the variability in size and arrangement of the cells they were often regarded as such. Ehrendorfer (17) and Krompecher (9) regarded many of them as alveolar sarcomata, other observers classed them as endotheliomata, but Kocher and Langhans (6) first suggested that the majority were carcinomata and that their method of producing metastasis in lymph glands was surprising. Later Chevassu (8) Nicholson (37) Ewing (18) Dew (14) and Bell (1) among others emphasized the essential distinction between these growths and the sarcomata. It is conceded by the majority of observers that they are derived from the cells of the seminal epithelium and Chevassu (8) coined the appropriate name seminoma for them. While recognizing their undoubtedly carcinomatous nature Ewing (18) classified them as 'embryonal carcinomata' and regarded them as a one-sided development of teratoma.

AMERICAN COLLEGE OF SURGEONS

1928 CLINICAL CONGRESS IN BOSTON

THE thirtieth annual Clinical Congress of the American College of Surgeons will be held in Boston the second week in October beginning Monday October 8 continuing until Friday October 12. Headquarters will be established at the Statler and Cleverly Plaza hotels. At the former hotel the large ballroom and adjacent five of the Coliseum with the large rooms on the mezzanine floor will be used for registration and ticket distribution. Full time rooms executive office exhibit to the ballroom with the Cleverly Plaza will be used for the continuing education with the exception of the International Meeting on Monday evening and the continuation on Friday morning which will be held in Symphony Hall.

The hospital program arranged by the committee will include clinical and demonstrations at the following institutions: Harvard University, Boston University and Tufts College medical school and the following hospitals: Beth Israel, Boston City, Boston Dispensary, Boston Lying-in, Boston General, Robert Brigham, Cambridge, Carnahan, Children's, Deaconess, Faulkner, Frodo, Hospital for Women, Huntington Memorial, Long Island, Massachusetts Eye and Ear, Massachusetts General, Massachusetts Homeopathic, New England

and Baptist, New England Hospital for Women and Children and St. Elizabeth's.

A committee on arrangements has been organized which includes the following:

Edward J. C. C. C.	Otto J. H. M.
Charles C. M. T.	D. H. J. S.
John D. M. M.	W. E. L. d. J.
Nathaniel M. L.	F. K. H. I. J.
Frank C. P. H.	H. I. V. I. d.
Alfred S. B. K.	J. d. B. L. d.
James B.	K. H. M. L.
John C. C.	W. J. M. T.
Arthur C. C. T.	H. I. M. h.
John C. C. H. M.	D. H. M.
Harold C. C.	Frederick S. S. W. L.
John C. C.	P. B. O. d.
John C. C.	William C. O. by
John C. C.	C. L. S. udd.
John C. C.	J. ph. I. St. t. n.
John C. C.	A. W. St. r. n.
John C. C.	J. m. W. Sto.
John C. C.	I. T. Sw.
John C. C.	H. K. W. K. e.
John C. C.	Wyma. Whitt. m.
John C. C.	H. Z.

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SARCOMATOUS TUMORS OF THE TESTICLE¹

BY HAI OLD DFW FRCS FACS MELBOURNE AUSTRALIA
S g t O t P t t M lb H p t l

IN a recent monograph (13) I emphasized the confusion that had existed for many years with regard to the nature of round cell tumors of the testicle. For long it was stated in many textbooks that sarcoma was the commonest tumor of this organ and that it was a peculiar exception to sarcomatous tumors in general in that it produced metastases in the lymphatic glands. As pathological observations accumulated and these tumors were studied in greater detail it was found that many testicular tumors were in reality teratomatous in nature. The pioneer work of Wilms (49) Pick (39) Chevassu (7) and Nicholson (36) among others showed that about 50 per cent of these tumors contained derivatives of one or all of the three primary germinal layers although derivatives of any one of these layers could grow in excess and produce what at first glance seemed to be a homogeneous tumor. Another important fact was recognized, i.e. that any of the derivatives could undergo malignant change with the production of a carcinoma or a sarcoma, the development of a carcinoma from the hypoblastic elements being most frequently seen. Various writers including Waldeyer (47) Breus (4) Malassez (30) Carnot and Marie (5) had described peculiar testicular tumors which characteristically showed invasion of the veins with the formation of an intravascular growth, sometimes extending through the vena cava to the heart. The French authors called these

sarcome angioplastique. Wlassow (50) and Schlagenhauser (43) first pointed out the now well recognized fact that these are in reality carcinoma, the majority being chorionic in type.

The other common tumors of the testicle are soft homogeneous growths resembling sarcomata both microscopically and macroscopically and on account of the variability in the size and arrangement of the cells they were often regarded as such. Ehrendorfer (17) and Krompecher (9) regarded many of them as alveolar sarcomata; other observers classed them as endotheliomata, but Kocher and Langhans (6) first suggested that the majority were carcinomata and that their method of producing metastasis in lymph glands was not surprising. Later Chevassu (8) Nicholson (37) Ewing (18) Dew (14) and Bell (2) among others emphasized the essential distinction between these growths and the sarcomata. It is conceded by the majority of observers that they are derived from the cells of the seminiferous epithelium and Chevassu has coined the appropriate name seminome for them. While recognizing their undoubted carcinomatous nature Ewing (18) classified them as embryonal carcinomata and regarded them as a one-sided development of a teratoma.

The writer (14) has reviewed this problem elsewhere and has brought forward conclusive evidence in favor of the view that they are

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AMERICAN COLLEGE OF SURGEONS

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Chas. C. M. t	D. F. Jo es
S. t	W. F. L. dd
J. H. D. M. ms	F. K. H. L. l. y
N. th. I. M. l	H. l. v. L. d
I. n. l. C. B. l. h	I. B. L. d
Al. I. S. B. g	K. H. M. l
J. F. m. Brn	W. J. M. t
L. I. Ch	H. I. M. h
A. th. I. C. l. t	Do. H. M. o
F. H. C. gh. m	F. K. S. N. w. l
Harv. C. h. g	F. B. O. ood
L. I. l	W. l. m. C. Ou. by
H. l. t. l. y	C. I. Scudd
C. S. D. l	J. ph. L. St. at
Fl. W. D. k. g	A. W. St. rn
A. W. D. l	J. m. W. St. ne
I. d. I. l	L. g. T. S
J. I. F. C. l. thw. t	H. old. W. l. k
W. l. I. C	W. ym. Wh. tt. m
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By HAROLD DE WITTSCHACK, M.D., M.F.L.D., AUSTRALIA
Surgical Pathologist, Melbourne

IN a recent monograph (13) I emphasized the confusion that had existed for many years with regard to the nature of round cell tumors of the testicle. For long it was stated in many textbooks that sarcoma was the commonest tumor of this organ and that it was a peculiar exception to sarcomatous tumors in general in that it produced metastases in the lymphatic glands. As pathological observations accumulated and these tumors were studied in greater detail it was found that many testicular tumors were in reality teratomatous in nature. The pioneer work of Wilms (49) Pick (39) Chevasu (7) and Nicholson (56) among others showed that about 50 per cent of these tumors contained derivatives of one or all of the three primary germinal layers although derivatives of any one of these layers could grow in excess and produce what at first glance seemed to be a homogeneous tumor. Another important fact was recognized, i.e. that any of the derivatives could undergo malignant change with the production of a carcinoma or sarcoma, the development of a carcinoma from the hypoblastic elements being most frequently seen. Various writers including Waldeyer (47) Breus (4) Malassez (30) Carnot and Marie (5) had described peculiar testicular tumors which characteristically showed invasion of the veins with the formation of an intravascular growth some times extending through the vena cava to the heart. The French authors called these

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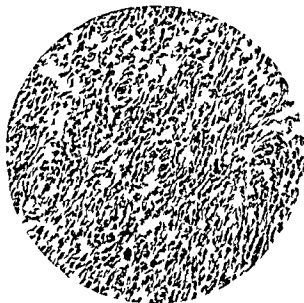
The writer (14) has reviewed this problem elsewhere and has brought forward conclusive evidence in favor of the view that they are

¹ From the Wilks Institute for Research in Pathology, Melbourne.



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g l l a a f f g n d d l u e
l l b c i

both histogenetically and clinically a group distinct from the teratogenous growth. They are as a rule composed of comparatively large cells with hyperchromatic nuclei and little cytoplasm and their stroma is often infiltrated with small lymphocytes. There is no doubt that taking histological appearance into consideration there may be great difficulty in distinguishing many of them from the sarcomata. Bell (1) who upholds the view that they are derived from the seminal epithelium has recently emphasized this diagnostic difficulty and in spite of their epithelial origin has adopted the term "carcinosarcoma" for those which histologically show a sarcomatous appearance. He states that this feature is probably related to the meso-



I b Se to f t y p l a f t m o f C e h o w
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thelial origin of the seminal cells and to reversionary tendency. It would seem that even histologically the carcinomatous characteristics predominate and that as their pathological and clinical behavior is carcinomatous their histological variations should not be overemphasized. The term "carcinosarcoma" is an unnecessary and a somewhat confusing addition to an otherwise overburdened nomenclature. For a similar reason the term "melothelioma" introduced by Adam (1) has never gained acceptance.

If both these groups of tumors are excluded it will be found that only about 1 per cent of testicular tumors can be regarded as primary sarcomata. True sarcomata however do occur and the previously unreported cases here recorded illustrate the various pathological type.

The sarcomatous tumors arise from the following tissue: (1) the mesoblastic elements of a teratoma (2) the intertubular connective tissue of the testis and epididymis (3) the coverings of the testis and the spermatic cord (4) blood or lymph borne metastatic emboli.

TERATOGENOUS SARCOMATA

The mesoblastic elements of teratogenous tumors give rise to the varied cellular stroma

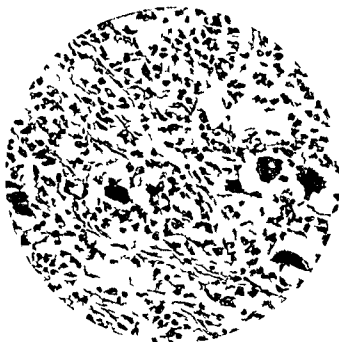


Fig. 3. Section of one portion of tumor Case 1 showing giant cells $\times 360$

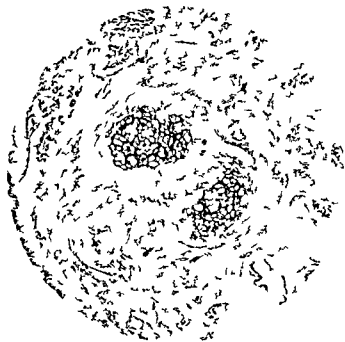


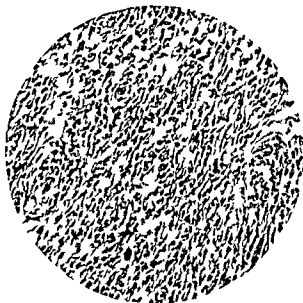
Fig. 4. Section Case 1 showing teratomatous element cartilage and the formation of glandular acini

of these growths. This in many cases retains a strikingly embryonic appearance so that the diagnosis of mixed sarcomatous tumors so common in the older records is not surprising. Other types of tissue such as cartilage, striped or unstriped muscle, lymphatic, myomatous or lipomatous tissue may occur and their occurrence in various proportions has given rise to the diagnosis of many types of tumor, their name depending on the predominating tissue present. It is now recognized that the presence of any heterogenous tissue in a testicular neoplasm is presumptive evidence of the teratogenous nature of such a growth. Malignant change in any of the mesoblastic derivatives with the production of various types of sarcomata is rare but has been recorded. There seems no doubt that many of the cases of spindle cell sarcoma of the testis described by earlier observers were in reality teratogenous; this fact being unrecognized in most cases because sections from all parts of the tumor were not examined. This appears to be so in the cases recorded by Kocher and Langhans (26), Ehrendorfer (17), Monod and Ferillon (34), and Debernardi (12). In examining an old museum specimen labelled pleomorphic spindle cell sarcoma, Wilms (49) found cysts lined with squamous and columnar

epithelium and areas of cartilage, thus proving its teratogenous nature. Cwing (18) is particularly insistent that great care must be exercised in spindle cell growths to exclude myomatous or other elements derived from a teratoma.

Case 1 illustrates some of the points

CASE 1. Teratogenous spindle cell sarcoma. H. K., aged 29 years, gave a history that 8 months before admission he had injured the left testicle which became tender and swollen. It subsided somewhat under treatment by counter irritation but after a month he noticed that it was slowly enlarging. This enlargement had become more noticeable during the last 2 months. He had had no pain since the accident and otherwise felt well. Examination revealed a large pyriform tumor extending to the external abdominal ring. The veins of the scrotum were very large, but the skin was freely movable over the mass. Neither the testicle nor the epididymis could be differentiated; no testicular sensation was elicited. The tumor was opaque to transillumination. The other testicle appeared normal. Palpation in the epigastric region revealed nothing abnormal. The other organs appeared healthy, and he stated that he felt well and had not lost any weight. Operation was advised and the radical operation for teratoma testis was carried out; no enlarged glands, however, being discovered in the lumbar region, although on account of the amount of retroperitoneal fat present a perfectly clean dissection was impossible. Four months later the patient returned complaining of shortness of breath, loss of weight and



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I T t m f t t l l h m
f no ll l f ft s a l d fu
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both histogenetically and clinically a group distinct from the teratogenous growth. They are as a rule composed of comparatively large cells with hyperchromatic nuclei and little cytoplasm and their stroma often infiltrated with small lymphocytes. There is no doubt that taking histological appearance into consideration there may be great difficulty in distinguishing many of them from the sarcomata. Bell (1) who upholds the view that they are derived from the seminal epithelium has recently emphasized the diagnostic difficulty and in spite of their epithelial origin has adopted the term "carcinosarcoma" for those which histologically show a sarcomatous appearance. He states that this feature is probably related to the meso-

thelial origin of the seminal cells and to reversatory tendencies. It would seem that even histologically the carcinomatous characteristics predominate and that as their pathological and clinical behavior is carcinomatous their histological variations should not be overemphasized. The term "carcinosarcoma" is an unnecessary and a somewhat confusing addition to an otherwise overburdened nomenclature. For a similar reason the term "mesothelioma" introduced by Adam (1) has never gained acceptance.

If both these groups of tumors are excluded it will be found that only about 2 per cent of testicular tumors can be regarded as primary sarcomata. True sarcomata however do occur and the previously unreported case here recorded illustrates the various pathological type.

The sarcomatous tumors arise from the following tissues: (1) the mesoblastic elements of a teratoma; (2) the intertubular connective tissue of the testis and epididymis; (3) the coverings of the testis and the spermatic cord; (4) blood or lymph borne metastatic emboli.

TERATOGENOUS SARCOMATA

The mesoblastic elements of teratogenous tumor give rise to the varied cellular stroma

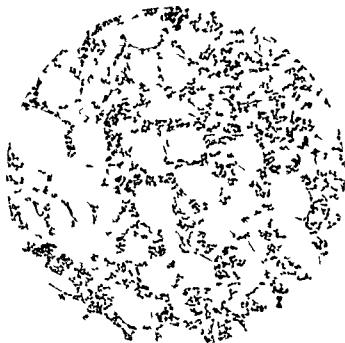


Fig. 1. Section of tumor in Case 1 showing area of fat by sarcomatous cell $\times 115$



Fig. 2. Section from tumor Case 2 showing area of calcified cartilage $\times 50$

Nature of the tumor The tumor is certainly an example of sarcoma developing in a teratoma. The presence of giant cells among the spindle cells in sarcomatous tumors of the testis has been referred to by Benenati (3), DeBarnardi (1) and Chevassu (7) and as pointed out by Ewing (18) suggests an origin from muscle fibers. This tumor almost certainly originated in this way since it contained scattered bundles of muscle fibers and in certain areas transitions between these and spindle cells. Unfortunately the metastases could not be examined. The presence of blood stained pleural effusion, the rapid development and the pulmonary signs indicate that multiple metastases existed in the lungs. It is almost certain that the tumor would have been found to be composed of pure spindle cell tissue. The appearance of an epigastric secondary glandular mass is of great interest. It may be that these glandular metastases were also of the same sarcomatous nature or it may be that as in some of the reported teratogenous cases mixed or carcinomatous secondary were also present. The absence of carcinomatous change in the numerous sections of the primary tumor does not favor the latter view.

The following is a record of a somewhat similar neoplasm

CASE 2 Teratogenous lipofibrosarcoma. C. H. aged 67 years was under the care of Dr. F. Grutzner to whom I am indebted for the case history and the specimens. Twenty years before being seen he had had an attack of mumps which was complicated by bilateral orchitis which subsided. Since then he had had no children but the uninvolved testicle showed no sign of atrophy. Seven years before seeking advice his right testicle began to enlarge and he thought that he had a rupture. This swelling had gradually increased but during the latter 12 months had grown much more rapidly, particularly during the last 3 months. There had never been any trauma to the organ and he had never been present and in spite of the great size and weight of the tumor he had been able to carry out his occupation of orchardist. He presented himself for examination because of the discomfort from dragging in the loin and the deformity produced by the tumor. When first examined he appeared to be in normal health, the large swelling of the right half of the scrotum being the only abnormality detected. The swelling of the right scrotum was very large, extending to the knee, pyriform in shape and of a solid consistency. The scrotal skin was smooth, not adherent but there was some chafing with mild local infection on the anterolateral aspect. The tumor was hard, regular in the upper part but somewhat nodular below. Neither the testis nor the epididymis could be differentiated and as the swelling extended into the inguinal canal the cord could not be well examined. There was no testicular sensation present and the mass was opaque to transillumination. No enlargement of the lumbar or inguinal lymphatic glands was detected. The diagnosis of neoplasm was made and operation



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l t l g a l k h t l l l u a l e f f o n h c h
l k t l f t e n t l b l l A s m a l l m
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A f t k h l t r t h j a t t p t l t h t h a l
l t t h 4 j l f k l t l o x a m a
t t h l i f u l t b l g e l t h e r e
m v n l g l p e t l l i m l v a n d m
l m a t h f e t t h e p u t t l e l 3 e e k a f t e
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P u l l i t h t m a l i n h j a u
i g t m t b e t m e t e r s i t l g e t
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h e r e t i n a n p l a c e a l t h u g h t h e g r t h h a d n o t



Fig. 2. Section of tumor from patient with type I
f t l m x

perforated the cavity. The cord hole some
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m a t o u e l e m e n t s

M o p l l y S t o n e s e e t a k e n f o m v a r i o u s
p o r t i o n s o f t h e c u t u r f a c e a n d m e d m i c r o
o p i c l l y I t w a s f o u n d t h a t t h e g e a t e r p a r t o f t h e
t u m o r w a s c o m p o s e d o f h o m o g e o u s p l l c e l l
s a m a t o u t u e (f g 2) I n t h i s t h e c e l l w e r e
a n g e l i n a l i f f e u r r e g l m a n n e a d i n v o l
n l e m b e d d e n i n a n e n t e c e l l u l a r m a t r I n
p a r t t h e c e l l r e i n t i m t e r a t i o n h i p t h
b l l v e e l m a y o f w h i c h a p p e a r e d m p l y a s
h n k s i n t h e n e p l a s t i t u e T h e n u c l e i w e r e
h y p e h o m a t u v a r i a b l n a e l t a i n i n g e c
t n s n d m t t i c f i g u r e s v e e n t u n o m m o
S c t t e r e l i g u l l y t h r o u g h u t t h e m v e e
g t c e l l t h t o t o f o e t r a l l y p l c e d n u c l e i
e m b l i g c l o s e l y t h e e n m t y j c a l p i n d l e
c e l l a m a o f t h t s u e (f i g 3)

L a g a r f e c r o i t h d e g e r a t i o c t l
b r k g d n d h e a n d t h s u r l f
p l t c e l l c o u n l b l o o l e s s l h a m o h a g c r e
l e t o f m a t u s t i u e r c p t n o m e
c t T h r e c l l e n l o u b t s t t h e s a r
m a t o u t u e o f t h g r e t r p a r t f t h e t u m o r
F u r t h e r c h e a l e l h o e v e r t a t o g e n o u e l e
m t i m e f t h e s e c t i T h e t o o k t h e f r m
o f t p d a n i u t r p d m u s c l f b e f e t a l a n l
a l l t c a t l a g e m y x m t a r e s a l a f e v c y t
l n c l t h l e p t h e l i u m s o m e e f l e l t h
m u c d m a t e r i a l (f g 4) A c r e f l e o f a l l t h
s e c t i h o e d n o e v i d e n c e o f a n y c e n m a t o u
t i s u e



A portion of the tumor were sectioned over 80 blocks being cut and examined. These revealed a cellular growth composed almost entirely of fibroblastic spindle cell set in a hyaline intercellular matrix resembling in every way a pure fibrosarcoma (Fig 6). There are many areas of degeneration and necrosis with the survival of neoplastic cell around blood vessels and here and there areas of cavitation within the tumor.

In some of the sections definite mitoses of lipoma spindle and myxomatous tissue with the fine spindle cell sarcomatous growth are seen (Fig 7) but nothing was found in the first fifty sections that could be regarded as evidence of the teratogenous nature of the growth. Sections of the occurrence of the growth showed a simple spindle cell sarcoma rather more active in appearance than the primary growth.

Nature of the tumor For some time it was difficult to decide in what category to place this tumor. The following suggestions were considered:

1 The tumor was an example of a liposarcoma originating in the fibrofatty testis such as sometimes results after orchitis due to mumps. Curling (11) and Smith (44) among others have referred to the total replacement of a testis by such fibrofatty tissue. As has been pointed out recently by McGuire (3) liposarcoma not infrequently develops in such pathological organs. There was in this case no evidence of previous testicular atrophy while the great size, the lack of homogeneity in the tumor and the type of sarcomatous change seemed to be against this view.

It was a primary liposarcoma of the spermatic cord which had extended down the scrotum and caused pressure atrophy and absorption of the testis. Such tumors are rare but have been recorded by Federnat and Martin (46) and others. These tumors are characterized by varying mixture of fatty and fibrocartilaginous tissue by very slow growth by their large size and by a tendency to local recurrence. The history of a swelling suggestive of a hernia in the early stages, the presence of so much heterologous fatty tissue, the slow growth, the low grade malignancy, and the local recurrence seemed to favor this view. The absence however of an accurate early history, the complete absence of the testis, the peculiar difference between the upper and the lower portions of the tumor made such a diagnosis unlikely so that it was thought in spite



FIG. 10. Bilateral lymphosarcoma of testis with a cutaneous nodule. One half size.

of the comparative rarity of lipomatous tissue in such growths to be an example of teratogenous lipofibrosarcoma in which all other elements had been suppressed.

3. With this possibility in view many more sections were cut and examined and the others were carefully reviewed to attempt to discover teratogenous elements. In section No. 84 areas of calcified cartilage (Fig. 8) were discovered while in some of the sections from the peripheral part of the fibrosarcomatous areas involuntary muscle bundles and lymphoid areas were found. In addition examination of other sections showed scattered giant cells rather similar to those seen in Case 1. There seems to be no doubt that the diagnosis of teratogenous fibroliposarcoma for this interesting tumor is justified. It is suggested that in this case as in the preceding the sarcoma was probably derived from the myogenous elements of a teratoma.

PRIMARY SARCOMA DERIVED FROM THE CONNECTIVE TISSUE OF THE TESTIS

Two apparently distinct types of primary sarcoma of the testis have been recorded although on account of their rarity we are not yet in a position to be certain of their histogenesis. These tumors are composed of small round cells and have been usually described as lymphosarcomata (a) unilateral lymphosarcoma—differing in no way from ordinary sarcoma as regards histology, course or metas-



Fig. 11. Section of tumor of right testis from same case as in Figure 10 from main tumor mass showing type of cell present. $\times 130$.

tases (b) lymphosarcoma—characterized by its appearance in both testes by its rapid growth and by the presence of multiple cutaneous sarcomatous nodules.

Lymphosarcomata of the first group are very rare but apparently authentic cases have been recorded by Nicholson (36) DeBarnardi



FIG. 12. Section of the same tumor as in Figure 10 showing infiltration of the epididymis. $\times 75$.



Fig 10 Bilateral lymphosarcoma of testis with a cutaneous nodule. One half size

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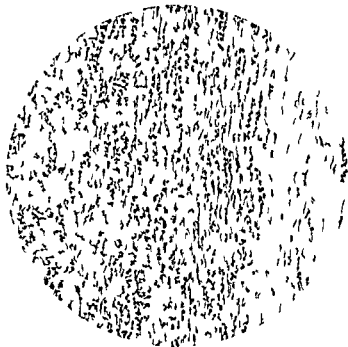


Fig 11 Section of tumor of right testis from same case as in Figure 10 from main tumor mass showing type of cell present $\times 130$

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Fig 12 Section of the same tumor as in Figure 10 showing infiltration of the epididymis $\times 75$

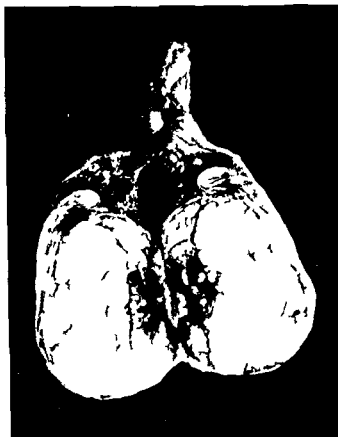


Fig. 15 Secondary embryonal sarcoma (Wilms tumor) of the left testicle. Child aged 2 months. Natural size

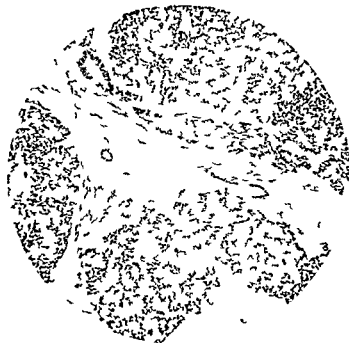


Fig. 16 Section of secondary Wilms tumor of the testis showing mixed structure. $\times 106$

his bed. These nodules which were extremely numerous varied in size from 0.5 to 3 centimeters in diameter were very vascular and caused thinning and finally ulceration of the skin. They were not painful until they became secondarily infected from ulceration. The two testicular swellings increased but the effusion into the tunical sac seemed to diminish the swelling on each side becoming opaque. The epididymis on the right side appeared to be enlarged. Iuncture revealed slightly blood stained fluid from the right tunica. Examination of the chest in the later stage showed some basal congestion but no signs of metastases or of pleural effusion. There was no demonstrable increase in the size of the liver or spleen nor could any tumor be felt in the abdomen. The patient gradually became cachectic and died in a state of coma 4 months after first being seen. A full autopsy was not allowed so that the pathological information available is unfortunately limited.

Pathology the testicles Both testicles were found to be the seat of a soft cellular type of growth (Fig. 10) and were about twice the normal size. The growths were homogeneous and vascular and had infiltrated the atrophic testicular substance and the epididymis. The outline was irregular and careful examination revealed several outlying foci of varying sizes apparently separated completely from the main mass. There were several small areas of hemorrhage but no cystic change or central degeneration.

The appearance and consistency of the tumors suggested a rapidly growing sarcoma. The cord was free contained no neoplastic extension and no nodules. The tunica albuginea was thickened and the tunica vaginalis on both sides had obviously contained fluid. On the right side there were numerous adhesions between the two layers of the tunica and some of the loculi thus formed contained blood clot probably the result of the exploratory puncture.

Microscopically the tumors were identical and were composed of small cells of lymphocytic type set in an irregular refringent reticulum (see Fig. 11). These cells had little cytoplasm but active hyperchromatic nuclei with occasional mitotic figures. They were seen infiltrating between atrophic tubules and at the edge were mixed with cells derived from disintegration of such tubules. Around the main tumor mass were multiple foci of similar cells and in some cases these appeared to be arranged around small blood vessels. Careful search for heterotypical tissues was made throughout the greater part of one of the tumors with negative results.

The cutaneous nodules were soft and extremely vascular and had infiltrated the subcutaneous fat widely and caused pressure necrosis of the epithelium. The latter however did not seem to be infiltrated a fact which is in keeping with the general sarcomatous appearances of the nodules. On microscopic examination they revealed an irregular infiltration of the subcutaneous tissues with a small lymphocytic type of cell similar to those of the testicular tumors.

Nature of the tumor Two explanations of the nature of this neoplasm are possible (a) that it is a bilateral primary sarcoma derived

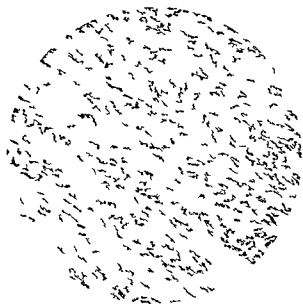


Fig. 1. Photomicrograph of a section of the tumor. (H. E. stain, 40X magnification.)

(1) Ehrenrdorfer (17) Chevassu (18) and the writer (19). The latter has been described elsewhere in the literature arrived at that a peculiar histological appearance and pathological structure of the tumor fulfilled the sarcomatous criteria. Figure 1 is a photomicrograph of a section of the tumor.

The tumor is believed to arise from the fine intertubular connective tissue of the testis although this tissue is irregularly deficient in lymphocytes. Ewing (18) in view of its extreme rarity and the frequency with which lymphoid tissue is found in teratogenous growth suggest that it may represent the one ideal development of a teratoma. Though he is inclined to regard all testicular growths as of this nature this view must be considered before a decision is made that any small round cell growth is derived primarily from the connective tissue of the testis itself.

Bell (10) has recently drawn attention to the fact that although most of the seminoma group of carcinomas are composed of large round cells with a clear cytoplasm like the permatocytes other are composed of smaller cells with darkly staining nuclei and much less cytoplasm. He suggests that the mesothelial origin of the germinal cell applies sound rea-

sons for individual variation and believe that reversionary tendencies of the epithelial cells play a large part in the production of the so-called lymphosarcoma. The suggestion that some of the small cell tumors are really epithelial in origin is also held by Chevassu who has maintained that many cases recorded by French observers as lymphosarcomata are in reality varieties of seminoma. He suggests that the small cell type may be derived from the spermatoblasts or other precursors of the spermatocytes.

However much uncertainty exists concerning the histogenesis of the already mentioned tumor there is no doubt that the tumors of the second group are distinct although these too have some peculiarities which are hard to explain. Tumors of this group were first described by Curling (11) and later by the French observers Malassez (31) Talavera (45) Monod and Terillon (34) and Rclus and Duplay (40). Cases have also been recorded by Ehrenrdorfer (17) Ewing (18) and Debarbardi (19). Chevassu has drawn attention to the confusion which has existed in the recent French literature where the two types of lymphosarcoma and seminoma are often confused under the name of lymphadenoma testis. The tumors of the second group are characterized in the majority of cases by their bilateral nature by their rapid course by the frequency of multiple cutaneous growths and by a histological structure resembling lymphosarcoma. The following case history illustrates some of the features of the group.

CASE 3. A. A. aged 84 years was first seen at a private dispensary of the right side of the scrotum which had been noticed for some time. On examination a translucent hydrocele was present and no enlargement of the testicle was detected. There was slight enlargement of the other testicle at that time. About 3 weeks later examination on re-examination of the left testicle which had become almost as large as the right. On examination it appeared solid and as opaque to transmitted light. A week later he was seen with multiple nodules beneath the skin of both forearms and both legs noting the thighs or arm. It seems probable judging by their size that these nodules were in reality prescient the time of the first examination although missed by the patient and the clinician. Four weeks later a nodule of the cutaneous growth began to ulcerate through the skin of the leg and he was compelled to take to

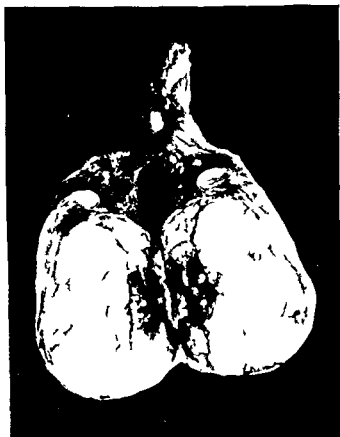


Fig. 15 Secondary embryonal sarcoma (Wilms tumor) of the left testicle. Child aged 7 months. Natural size.

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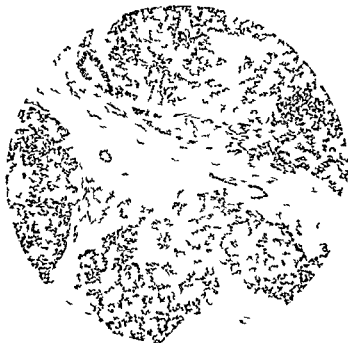


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Nature of the tumor. Two explanations of the nature of this neoplasm are possible: (a) that it is a bilateral primary sarcoma derived

Sarcomata of the tunica albuginea Hinman and Gibson were able to collect 12 cases which could be regarded as authentic sarcomata of the tunica. The case of Home (3) and Craven (9) described by Curling (11) are the earliest recorded. The greatest difficulty is in differentiating these from tumors of the underlying organ. Apart from their rarity they are of no special interest as they behave in a typical manner as regards course and metastases.

Sarcomata of the epididymis As confusion has existed in the description of tumors of this region it is not surprising that sarcoma is the most commonly recorded. However the diagnosis of sarcoma must be accepted with reserve and an attempt made to correlate the descriptions given with modern pathological conceptions. The majority of purely epididymal tumors are probably carcinomata. Interesting cases which appear to fulfil the sarcomatous criteria have however been recorded among others by Curling (11) Edwards (16) Russell and Wood (4) Kolster (8) Grossman (5) and Miyata (33).

Sarcomata of the spermatic cord A great number of sarcomata of various cellular types have been recorded in this region and seem to be second in frequency to the lipomata. There seems no doubt that some of the recurrent lipomata of this region are very closely allied to liposarcomata. Series of cases have been recorded by Fasano (19) Celso (6) Tedat and Martin (46) Patel and Chaher (8) while Hinman and Gibson (2) have fully reviewed the reported cases. Fibrosarcomata and liposarcomata are the most common types and it seems that many of these have origin in a benign tumor which has been growing slowly over a long period. The possibility that some of these tumors are of a teratogenous nature has been emphasized by Kolisko (7) and Ewing (18).

Sarcomata arising from the peritesticular connective tissues are rarer although cases have been recorded by Miyata (33) Rokitsky (41) and Neumann (35). The latter have noted the presence of giant cells in these tumors and suggest the possibility of a myogenous origin from the upper part of the gubernaculum testis.

The following case history is that of a sarcoma of the retrotesticular tissues and I believe it to be of a myogenous nature.

CASE 4. M. A. aged 17 years stated that about 3 years before admission to the hospital he had been struck on the left testicle by a cricket ball but that apart from the severe pain at the time he had had no ill effects. Two and a half years later he noticed a small lump behind and below the left testicle. This was quite painless but enlarged steadily. He had no other symptoms and appeared to be in perfect health. On examination a hard non-tender egg-shaped tumor was present below and behind what appeared to be a normal testicle. The epididymis could not be differentiated by palpation and it was thought that the tumor was a primary growth of that organ. The cord was normal. Rectal examination was negative and the contents of the other side of the scrotum appeared normal. The Wassermann reaction was negative.

Simple orchidectomy with high division of the cord was performed and the patient was still alive and well 3 years after the operation.

Pathology When the tissue removed was examined it was found that the tumor was independent of the testis, epididymis and cord. It was fairly well encapsulated homogeneous of a firm consistency and measured 7.5 centimeters by 4.5 centimeters in its longest diameters. It was pale pink in color and the cut surface resembled that of a fibrosarcoma. There were no areas of hemorrhage, cystic degeneration or softening. The colored plate (Fig. 13, frontispiece) gives its relations and approximate size. Below it tended to merge into the gubernaculum testis.

Microscopical examination of the whole of one half of the tumor was carried out by cutting serial sections. It was found to be composed in the main of fibroblastic spindle cells and conformed in all respects to the classical appearance of a spindle cell sarcoma of low malignancy (Fig. 14). The tumor was not very vascular but there was a tendency for the vascular channels to be represented by clunks with poorly developed walls rather than by definite vessels. In spite of careful search no trace of any teratogenous elements could be discovered. In one portion of the growth a few giant cells were discovered. These cells measured up to 50 μ in diameter and had four to six centrally arranged nuclei. They resembled those seen in myosarcomatous growths of the uterus and thus suggest that this tumor is similar to that described by Neumann being in all probability derived from the gubernaculum testis.

SECONDARY SARCOMATA OF THE TESTICLE

Secondary sarcomata of the testicle are very rare and usually develop as the result of the carriage of metastatic emboli by the blood stream from a primary sarcoma elsewhere.

from the connective tissue elements of the testicle with secondary cutaneous metastases and (b) that both the testicular and cutaneous tumors are metastatic and secondary to some other primary source.

In view of the small amount of lymphatic tissue in the testis the peculiar origin of the tumors from several centers the rarity of any other form of bilateral neoplasm and the peculiar distribution of the cutaneous deposits it is difficult to accept the first explanation and it has been discarded by the majority of writers.

In the case recorded by Chevassu (5) and Mond and Terillon (44) generalized enlargement of the abdominal lymphatic gland was present and is pointed out by Chevassu it is possible that a retrograde lymphatic spread of the neoplastic process from the retroperitoneal lymph glands may be the explanation of the bilateral testicular involvement. It may be that the abdominal lymphatic glands are the seat of a lymphosarcoma which metastasizes in this peculiar manner. Some of the French observer and more recently Cumston (10) consider that the condition allied to an aleukemic lymphatic enlargement there being a rule no coincident alteration in the nature or number of the leucocytes in the blood. Another suggestion is that the condition is a form of Hodgkin's sarcoma with a somewhat peculiar distribution of metastases. All observers are agreed upon the frequency of lymphatic glandular enlargement and of the fatal nature of the disease. Only by careful exhaustive postmortem examination will the true nature of the lesion be elucidated. From the somewhat meager knowledge at our disposal it seems to me that both the testicular and cutaneous nodules must be regarded as part of a general lymphocytic deposition if they are metastatic.

TUMORS ARISING FROM THE INTERSTITIAL CELLS

The function of the interstitial cells is apparently to supply an internal secretion which determines the development of secondary sexual characteristics. Various observers have described tumor formation from these cells but the exact nature of the cases has

not yet been determined. Waldeyer (48) named one specimen plexiform angiosarcoma while Hansemann (1) suggested that certain of the alveolar sarcomata and carcinomata had a similar origin. In atrophic testes in which the seminal tubules have undergone degeneration or disintegration there is often an apparent hypertrophy of these cells and at times an appearance of overgrowth.

This led Durck (15) to report five cases in atrophic testicles both descended and undescended in which multiple hyperplasia of the cells had occurred. He was however uncertain whether the condition should be regarded as neoplastic or as a simple hyperplasia.

A comparatively large tumor measuring 9 centimeters by 1 centimeters and composed of polyhedral cells with active nuclei and irregular mitotic figures was described by Kaufmann (4). The type of cells present and their staining reactions led him to regard it as a sarcoma although he was somewhat guarded as to its malignancy.

Chevassu (7) also described a similar tumor about the size of a hen's egg which was reddish yellow in color on section. The cells composing it were large with abundant cytoplasm contained pigment and vacuoles had small active nuclei and were apparently identical with the interstitial cells. He thought the tumor was benign. No one has as yet observed any metastase in tumor of this type and none of the recorded cases can definitely be proved to be sarcomatous. It is important however to bear in mind the possible origin of malignant tumors from this source especially in atrophic testes and it may be that some of the typical homogeneous tumors will be proved to be derived from these cells.

SARCOMATA DERIVED FROM THE EXTRATESTICULAR STRUCTURES THE TUNICA VAGINALIS THE EPIDIDYMIS AND THE SPERMATIC CORD

These tumors are comparatively rare and therefore most of them are reported so that Hinman and Gibson (2) were able to collect a great variety of cases from the literature. These writers deal with the subject very fully and give an exhaustive bibliography.

MECHANISM OF EMPTYING OF THE GALL BLADDER AND COMMON DUCT¹

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AND

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S. G. I. S. H. I. T. H. A. T. I. S. G. I. G. T. B. T. D. I. I. D.

IN previous publications although admitting the possibility of intrinsic muscular contractions of the gall bladder we have questioned the position taken by many that these contractions constitute the only mechanism of emptying. Thus we have stated (4) "Though the gall bladder has an elastic or contractile mechanism which exerts pressure on its contents until it has reached a minimum pressure we have not been able to demonstrate an actively contracting movement due to its intrinsic musculature and again in a later article (6) "In the light of the new evidence we feel that perhaps we have not assigned sufficient importance to the factor of intrinsic contraction of the muscle and that this factor should be added to the physical forces mentioned responsible for the emptying of the gall bladder but we are unwilling to ascribe to muscular contractions the exclusive role in this drama. The observations of Boyden (5) and of Whitaker (7) that the gall bladder is frequently found collapsed after a meal of egg yolk or fat have shed further light on the emptying mechanism.

In a re-investigation of this problem we have made use of the roentgenological method adopted by Whitaker (8) for experimental animals. The gall bladder is filled with iodized oil (iodopin) by open laparotomy and on the following day after recovery of the animal X-ray films are made. Under these conditions it is found that if the animal is starved following the operation no emptying of the gall bladder occurs for 2, 3, or more days but the administration of a meal of fat or preferably of egg yolk and cream causes a flow of oil from the gall bladder into the duodenum. This emptying of the gall bladder commences within a short time after the administration of the meal and continues over a period of 3 or 4 hours. In some cases in the cat the gall bladder is completely empty by this time more

frequently traces of iodopin remain and these traces may then persist until another meal is ingested (Fig. 1).

As a result of such observations Whitaker has concluded "The emptying of the gall bladder is produced primarily by the action of its muscular tunic extrinsic mechanical factors having no appreciable effect" (9). Burget (3) however does not concur with this conclusion. He states "Although following such procedure there is a noticeable reduction in size to deduce from this evidence that the gall bladder expels bile by forcibly contracting would seem unwarranted in view of its great elasticity."

To exclude the effect of elasticity of the gall bladder and the other mechanical factors which have been suggested to account for its emptying the following experiment was performed. The gall bladder of a cat was filled with iodopin and a cannula was inserted in the cystic duct pointing upward toward the gall bladder. The cannula was attached to a thin rubber bag made from a finger cot which was placed in the abdomen. The following day a meal of egg and cream was administered by stomach tube and roentgenograms were made immediately after the meal and 5 hours later (Fig. 2). At the time of the first roentgenogram 4 hours after operation all the iodopin was still in the gall bladder although the elasticity of the wall and the changes in the intra-abdominal pressure had had every opportunity to function. Five hours after the egg meal a considerable degree of emptying of oil from the gall bladder into the rubber bag had taken place. It would seem from this experiment that the discharge of bile from the gall bladder is not necessarily dependent upon elasticity or extrinsic factors and may be the result of muscular activity.

Doubtless however muscular activity is not the sole agent normally engaged in the



Fig. 3 Upper picture gall bladder of monkey filled with iodized oil 24 hours after operation before egg meal. Lower picture 7 days later after several egg meals. Very little emptying has taken place.



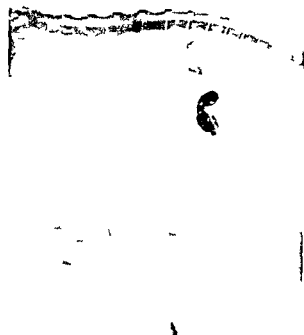
Fig. 4 Abdomen of cat with rubber bag filled with iodized oil. Note the changes of configuration suggestive of peristaltic waves.

was placed a rubber bag partly filled with iodopin. Changes in shape are seen which are of course entirely due to variations of pressure from adjacent viscera. These changes might easily be misinterpreted as being due to peristalsis.

This pressure of adjacent organs (that is the intra abdominal pressure) has been adduced by many investigators to explain the emptying of the gall bladder as well as its change of shape. Apparently however it plays a very minor role. In the experiment previously described in which the cystic duct of a cat was catheterized by a glass cannula leading to an intraperitoneal rubber bag vigorous struggling due to the passage of a stomach tube failed to express a single drop of iodopin from the gall bladder (Fig. 7). Further investigations of the importance of this factor point to the same conclusion. In a dog a cannula leading to a rubber bag was inserted into the common duct, and the wound

tightly closed around a rubber tube. The intra abdominal pressure was then alternately raised and lowered by passing air through the tube into the abdominal cavity the pressure varying from 0 to 60 centimeters of water. After half an hour of such variations in the pressure the bag was examined and found to contain merely a few drops of bile expressed from the ducts; the gall bladder remained full.

As it was felt that objection might be raised to this experiment because of the presence of air in the peritoneal cavity, a further experiment was performed in which variations of pressure were induced comparable to those occurring normally. In this case in a dog the common duct was intubated with a cannula and the abdominal pressure was then raised periodically to simulate respiration by the forced insufflation of air into the trachea counter pressure being applied to the abdominal wall by means of a tight binder. Consider



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emptying we believe that two other factors particularly take place in this process namely (1) a flushing out by the flow and ebb of fresh bile from the liver and (2) elastic recoil of the distended viscus. The question of flushing out of the gall bladder by bile from the liver has been considered in a previous paper (4). It was shown by cholecystography that a rubber bag substituted for the gall bladder of a dog will fill and empty somewhat after the manner of the normal viscus. Further evidence of the importance of this factor is offered by the following experiment. In a dog the hepatic ducts were ligated above the entrance of the cystic duct and the gall bladder was filled with lipiodol. Complete emptying had not occurred at the end of 30 days although during this time the dog was fed egg yolk and cream in addition to regular diet. This result indicates that the ebb and flow of bile from the liver is a factor of some importance in the emptying of the gall bladder.

In many animals the anatomical arrangement of the gall bladder which may be closely attached to a large area of liver or even completely embedded in it renders the flushing out by bile of especial importance for in these cases it is difficult to see how even vigorous contraction of the wall could completely empty the gall bladder. In the monkey (*Macacus rhesus*) in which this anatomical arrangement is the rule complete emptying of the gall bladder may be delayed for as long as 11 days even if meal of egg yolk and cream are administered (Fig. 5).

It is difficult to determine whether the muscular activity of the gall bladder is of the nature of a true peristaltic action or of a change in tone. Changes in size and shape of the gall bladder as seen on X-ray films have been taken to indicate the presence of peristaltic action but such evidence is not conclusive since similar change in shape may result from other cause such as the pressure of other viscera. This point is demonstrated by Figure 4 which shows a cat in the abdomen of which

ter is opened a spurt of bile is seen to follow each contraction

We have attempted to show in the cat movements of the common duct by an indirect method. The common duct was filled with iodopin and all the hepatic ducts and the cystic duct were ligated to prevent its being washed out by fresh bile. Roentgenograms taken at intervals showed that the common duct emptied during a period of 12 hours. This seems to indicate active movements of the common duct but other factors such as the action of the duodenum may be present.

ABSORPTION FROM THE GALL BLADDER

In searching for an alternative opaque material to iodized oil for experimental use we found that sodium iodide rapidly disappears after injection into the gall bladder. This rapid disappearance at first believed to result from emptying from the gall bladder proved to be due to its absorption through the gall bladder wall and occurred just as rapidly after ligation of the cystic duct. Chemical tests showed the complete disappearance of the sodium iodide from the gall bladder within a few hours. Subsequent roentgenograms showed its presence in the urinary bladder (Fig. 5). The process is probably a physical one not dependent upon a specific property of absorption by the gall bladder wall. The disappearance of the sodium iodide from the gall bladder after ligation of the cystic duct was not hastened by the administration of a fat meal.

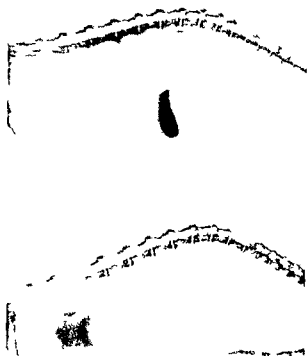
CONCLUSIONS

The emptying mechanism of the gall bladder is dependent partly upon an intrinsic mus-

cular action partly upon its elasticity and partly upon the ebb and flow of fresh bile from the liver. The last factor is of especial importance in animals in which the anatomical arrangement of the gall bladder precludes its complete contraction as in the monkey. Variations of intra abdominal pressure play a minor role in the emptying of the gall bladder. Peristaltic contractions of the common duct have been observed in pigeons and it is suggested that they may take part in the flow of bile in some mammalia. The response of the gall bladder to a fat meal depends upon its absorption through the intestinal wall. It is not proved whether the response of the gall bladder is due to hormone action or nervous excitation. Sodium iodide is absorbed by the gall bladder wall.

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able changes in intra abdominal pressure such as coughing caused no change in the size of the shadow of the gall bladder and even when the cannula was led outside of the abdomen only a few drops of bile the actual duct content were expelled. It would seem therefore that the intra abdominal pressure plays a very small part in the emptying mechanism of the gall bladder.

NATURE OF THE RESPONSE OF THE GALL BLADDER TO THE EGG MEAL

The observation of So man () that the gall bladder emptied normally in a patient who had had a resection of the pylorus and gastro jejunostomy suggests that the response does not depend upon local stimulation of the mucous membrane of the duodenum. Whitaker claims that the emptying of the gall bladder is independent of the flow of pancreatic juice but we have not confirmed this latter finding. We excluded pancreatic juice from the duode-

num by separating the pancreas from the duodenum and by ligating the pancreatic duct. In 3 cats and 1 dog and in these animals emptying of the gall bladder occurred after successive meals of egg and cream.

There is some evidence that the gall bladder is influenced by certain internal secretions such for instance as adrenalin but the interpretation of this action is not quite clear. After complete removal of both suprarenals the gall bladder empties normally in response to a fat meal an observation made by Boyce and confirmed by us. In a further investigation of a possible hormonal action we have injected intravenously secretin insulin pancreatic juice and alcoholic and acid extracts of cow and dog gall bladder all of which injections had no effect on the size of the gall bladder. Nor did the direct injection of eosin into the gall bladder accelerate its emptying.

COMMON DUCT

The common duct is generally looked upon as merely a passive channel and indeed its thin walls and the paucity of muscular fibers lend support to this belief. Nor has any spontaneous movement of the common duct been observed in man or other mammalia. Comparative and experimental studies suggest that it may have a more important role for many fowls the common duct exhibits well marked muscular contractions. The contractions are easily seen in the pigeon and other birds as has been observed by Doyen (5) and others. To observe these contractions in the pigeon the abdomen is opened under ether anesthesia and access obtained by removing the lower part of the sternum. Active movements of the common duct are then readily visible. They occur quite frequently sometimes every 5 or 10 seconds and are of the peristaltic nature a wide relaxation phase preceding the contraction and extending rapidly from the portal fissure down to the papilla of Vater. As the duct is thin walled it is easy to see dark bile accumulating at the upper end of the duct and then rapidly being propelled down into the intestine. If the la-

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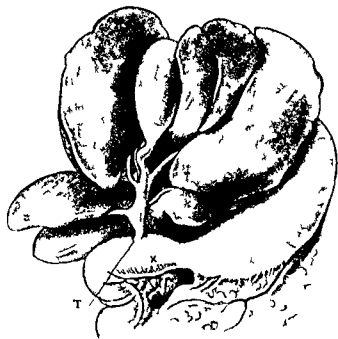


Fig. 1. Gross appearance of the gall bladder and bile ducts of Dog 815 15 days after the transplantation of the proximal segment of the divided common duct. A indicate the site of the ligated sphincter of Oddi and T the site of the transplantation. Half size.

After 24 hours it had disappeared completely (Fig. 3).

The dog was in excellent condition and was killed with ether on April 14, 1927, 175 days after operation. The gross appearance of the gall bladder and bile ducts at autopsy is shown in Figure 1. The size and shape of the gall bladder corresponded closely to the cholecystograms; it was filled with dark green viscid bile which was sterile upon culture. The cystic duct was normal. The common duct and the main hepatic ducts were dilated. The intramural segment of the transplanted duct was patent. The site of the choledochoduodenostomy was 4 centimeters from the pyloric sphincter; this was closer to the pylorus than at the original transplantation due probably to retraction of the duct during the process of healing. A few thin omental adhesions surrounded the lower end of the duct. The old distal stump of the divided common duct was recognized by a small nodule on the posterior surface of the duodenum (indicated by X in Fig. 1).

Dog 8716. Male. Weight 11 kilos. Operation October 25, 1926. The proximal end of the divided duct was implanted into the duodenum 8 centimeters from the pyloric sphincter. The first series of cholecystograms which was taken December 7, 1926, 43 days after operation showed a gall bladder shadow of normal outline and density at the 18-hour observation. After the feeding of egg yolk and cream the following changes occurred: at 1 hour the shadow was smaller and more dense; at 3 hours it had returned to its original size; at 6 hours there was again a definite diminution in size with increased

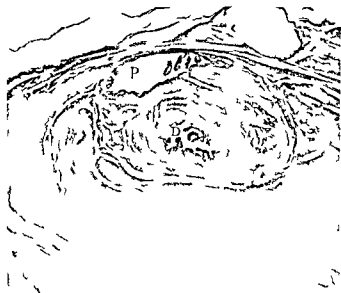


Fig. 2. Dog 871. Transplanted duct in the muscularis of the duodenum. Due to the tortuous course of the duct the proximal P and the distal D end appear in the same section. $\times 15$.

density. After 4 hours the shadow had disappeared (Fig. 6). At the time of this cholecystography the dog was in good condition but subsequently it lost weight.

A second series of films which were taken March 11, 1927 (94 days after the first series) did not disclose a gall bladder shadow. Additional series were taken March 18 and March 29 with the same negative results. The dog was killed with ether on April 9, 1927, 166 days after operation. At autopsy numerous adhesions were found at the site of the transplantation which was 6 centimeters from the pylorus. One of the adhesions extended over the cystic duct and occluded its lumen. The gall bladder contained a small amount of thick inspissated bile; its wall was thickened. The common duct was slightly dilated. The intramural portion of the duct was patent. The site of the original occluded sphincter was identified.

In both dogs microscopic examination of the liver gall bladder, hepatic and smaller bile ducts and pancreas revealed no abnormalities. The epithelium of the common duct was flattened.

RESULTS

In order to interpret properly the cholecystograms which were obtained after division and transplantation of the extramural segment of the bile duct they were compared with the gall bladder shadows obtained from 2 normal dogs under the same conditions the same technique being used. In the first dog a normal cholecystogram was secured and the feeding of egg yolk and cream caused a progressive diminution in the size of the

GALL-BLADDER FUNCTION AFTER DIVISION OF THE COMMON DUCT AND TRANSPLANTATION OF THE PROXIMAL SEGMENT

WITH A HISTOLOGICAL STUDY OF THE REPAIR AT THE SITE OF TRANSPLANTATION¹

By BENJAMIN N. BERG, M.D., NEW YORK

F m th D p m t f P h l d s g y C ll f Ph d s C l m b U t y

TECHNIQUE

ACCORDING to the law of contrary innervation promulgated by Meltzer (7) bile storage and bile discharge are controlled by a mechanism of reciprocal reflexes between the gall bladder and the sphincter of Oddi. The observation of Potter and Mann (8) and McMaster and Elman (6) supported this view. On the other hand Burget () and Copher and Kodama () minimized the importance of the action of the intramural segment of the common duct and emphasized the role of the duodenal musculature in the control of the flow of bile into the intestine.

In order to determine experimentally whether the sphincter is essential for normal gall bladder function, complete exclusion of the sphincter and complete severance of its neuromuscular continuity with the gall bladder must be insured. In addition a reliable method of observing the action of the gall bladder under relatively normal conditions is necessary. A consideration of these factors suggested the procedure which was employed in the following experiment.

The common duct was divided extramurally and the proximal segment was transplanted to another part of the duodenum. This allowed the duodenal musculature to act directly upon the wall of the duct (which was practically free of intrinsic smooth muscle fibers); the sphincter was eliminated and the neuromuscular connection with the gall bladder was severed. In order to insure firm union at the site of the transplantation a number of weeks were allowed to elapse. Then the function of the gall bladder was determined by means of serial cholecystograms made according to the method described by Graham Cole and Copher (5). This method was chosen because it permitted frequent observations of the filling and emptying of the gall bladder under normal conditions.

Under ether anesthesia and with aseptic precautions the common duct in dogs was isolated and doubly ligated just above its entrance into the duodenum. A linear incision 2 centimeters long was made in the anterior surface of the duodenum 6 centimeters and 8 centimeters respectively from the pyloric sphincter. The duct was divided $\frac{1}{2}$ centimeter proximal to the ligature and the free end was fixed at the lower angle of the opening in the duodenum which was then closed by inversion sutures. Silk was used throughout.

Cholecystograms were obtained in the following manner: 0.1 grams of sodium tetraiodophthalate per kilo bodyweight was injected intravenously. Eighteen hours after the injection of the dye the first X-ray film was taken. Then the dogs were fed with the yolks of 3 eggs in 100 cubic centimeters of cream (1) and films were taken at intervals of 1, 3, 6 and 4 hours after the meal.

EXPERIMENTAL RESULTS

Dog 8715 Male Weight 15.4 kilos Operation October 1, 1926. The proximal stump of the divided common duct was implanted into the duodenum 6 centimeters from the pyloric sphincter. The pictures of the first series of cholecystograms were taken December 14, 1926, 54 days after operation. The gall bladder shadow was normal in size and density at the 18 hour observation. Following the feeding of the egg yolk and cream mixture there was a progressive diminution in the density of the shadow but only a slight decrease in size at the 1, 3 and 6 hour periods. After 24 hours the shadow was still present.

A second series of X-rays was taken April 1, 1927, 119 days after the first series. The gall bladder shadow was of normal size and density at the 18 hour period. After the meal however the results differed from those obtained at the previous examination. At this observation there was a progressive decrease in the size of the shadow with an increase in the density at the 1 and 3 hour periods. At 6 hours the shadow was about the same as at 3 hours.



FIG. 4 (left) Dog 815 At the opening of the transplanted duct in the duodenum The muscularis of the duodenum *M* surrounds the base of the bile duct *B* which has villi *I* protruding into the lumen of the intestine $\times 125$

FIG. 5 Dog 8715 Transition from bile duct epithelium *B* to intestinal epithelium characterized by goblet cells *G* Taken from the area included in the rectangle in Figure 3 $\times 5$

shadow with an increase in density at the 1 and 3 hour observations at 6 hours the shadow was the same size as at 3 hours but less dense after 24 hours it could be outlined faintly. In the second dog feeding caused no perceptible change in the size of the shadow but its density was decreased in the 1 and 3 hour films at 6 hours the cholecystogram was practically the same as the original one at the end of 24 hours a definite shadow was still present. These observations indicated the variations that occurred in the cholecystograms of normal dogs following an egg yolk and cream meal. Similar variations were observed by Graham (4) in dogs and by Whitaker and Boyden (9) in man.

A comparison of the roentgen appearance of the gall bladder in the experimental dogs with that of the normal dogs showed that the experimental results were well within the limits of normal variations.

The persistent absence of a gall bladder shadow in dog 8716 in the second series of roentgenograms was explained at the autopsy by the discovery of an adhesion which occluded the lumen of the cystic duct. This oc-

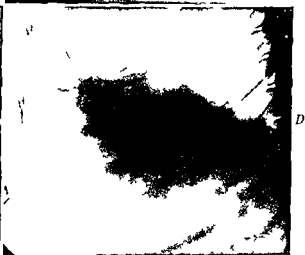
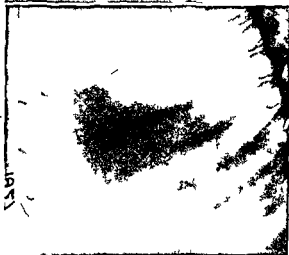
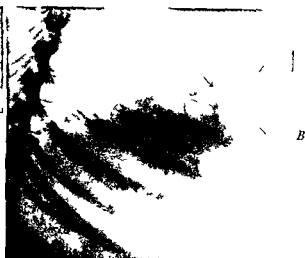
curred subsequent to the earlier series in which the filling and emptying of the gall bladder were normal.

STUDY OF THE REPAIR

Although choledochoduodenostomy has been performed successfully in man and in dogs little is known about the nature of the repair at the site of the transplantation. The 2 dogs which were used in the preceding experiment afforded the opportunity to make a detailed histological study of the intramural portion of the transplanted duct and the process of healing.

The segment of the duodenum which contained the transplanted duct was removed immediately after death and fixed in Zenker's fluid. Then the specimen was embedded in paraffin and serial cross sections were made and stained with hematoxylin-eosin and by Van Gieson's method.

The character of the repair was essentially the same in both dogs. Due to the fact that the duct penetrated the duodenal musculature in an irregular S-shaped manner two lumina appeared in some of the sections. *P*



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FIG. 4 (left) Dog 8715. At the opening of the transplanted duct in the duodenum. The muscularis of the duodenum *M* surround the base of the bile duct *B* which has small protrusions into the lumen of the intestine. $\times 15$.

FIG. 5 Dog 8715. Transition from bile duct epithelium *B* to intestinal epithelium characterized by goblet cells *G*. Taken from the area included in the rectangle in Figure 3. $\times 5$.

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Although choledochoduodenostomy has been performed successfully in man and in dogs little is known about the nature of the repair at the site of the transplantation. The 2 dogs which were used in the preceding experiment afforded the opportunity to make a detailed histological study of the intramural portion of the transplanted duct and the process of healing.

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The character of the repair was essentially the same in both dogs. Due to the fact that the duct penetrated the duodenal musculature in an irregular S-shaped manner two lumina appeared in some of the sections. *P*



Fig 6 Chol v t m f D 8 6 43 d ys fte d ct tr l t t on \ 8 hours ft
je t f dy f t g B d C 3 a d 6 h r s r p ct ly aft f ed g eg yolk d m m t
l 4 h ft f d g m pl t d pp a f h d

representing the proximal end and *D* the distal end of the same duct in Figure 1. The lumen of the intramural part of the duct was smaller than that of the somewhat dilated extramural segment.

The structure of the duct remained intact. The wall consisted of fibrous tissue interspersed with a few smooth muscle fibers and was united to the adjacent duodenal musculature by a layer of connective tissue which was practically an integral part of the wall itself. The mucosa was thrown up into folds and villi which were lined by simple columnar epithelium (Fig 1). Toward the periphery of the cells the cytoplasm contained fine lipid droplets which are found normally in the epithelium of the biliary tract. A few glands lined by the same type of cell were present in the submucosa.

The transition from bile duct epithelium to intestinal epithelium occurred at the duo-

denal orifice of the duct (Fig 4) and was identified by the appearance of goblet cell (Fig 5). The site of union of the apposed surfaces of the duodenum was marked by an irregularity in the arrangement of the smooth muscle fibers and a thin connective tissue scar. Some of the sutures were still *in situ*.

No histological change was observed in sections which were made of the original obliterated sphincter of Oddi. The epithelium stained well, the villi which are a normal feature of the mucosa of the sphincter were present and the smooth muscle fibers of the wall were intact.

The fact that normal cholecystograms were obtained indicated that the flow of bile into the duodenum was not affected appreciably by the distortion of the duct which was found at the site of the transplantation.

The regeneration of the mucosa of the transplanted duct was characterized by the for-

mation of villi. Normally the latter are not found in the mucosa of the extramural segment of the common bile duct. The union between the duct epithelium and the intestinal epithelium occurred at the orifice of the duct without any interruption in the continuity of the mucosa.

After prolonged ligation and disuse the structure of the original sphincter remained unaltered.

SUMMARY

1. After complete division of the common duct and transplantation of the proximal segment relatively normal cholecystograms were obtained in dogs.

A specialized neuromuscular relationship between the gall bladder and the sphincter of Oddi was excluded.

3. A study of the repair at the site of the transplantation was made.

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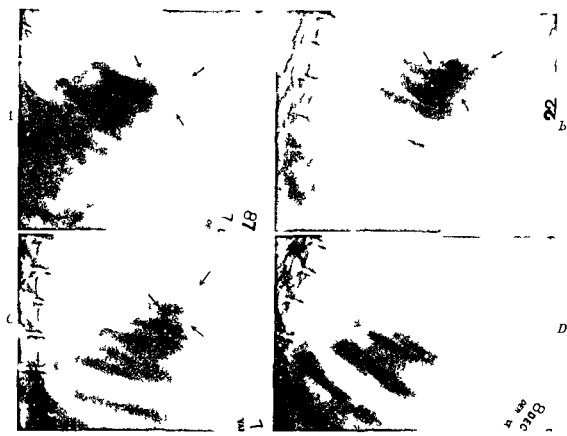


Fig 6 Ch l cv t m f D s o 4 d y ft d t t a pl t t o A S h r s ft
 j t f l f t l d C i d 6 l p e t l y f t f d g g y l k d c e m m t
 D 4 h ft f t g p l t l p p f h l

representing the proximal end and D the distal end of the same duct in Figure 1. The lumen of the intramural part of the duct was smaller than that of the somewhat dilated extramural segment.

The structure of the duct remained intact. The wall consisted of fibrous tissue interspersed with a few smooth muscle fibers and was united to the adjacent duodenal musculature by a layer of connective tissue which was practically an integral part of the wall itself. The mucosa was thrown up into folds and villi which were lined by simple columnar epithelium (Fig. 2). Toward the periphery of the cell the cytoplasm contained fine lipid droplets which are found normally in the epithelium of the biliary tract. A few glandular cells of the same type of cell were present in the submucosa.

The transition from bile duct epithelium to intestinal epithelium occurred at the duo-

denal orifice of the duct (Fig. 4) and was identified by the appearance of goblet cells (Fig. 5). The site of union of the apposed surface of the duodenum was marked by an irregularity in the arrangement of the smooth muscle fibers and a thin connective tissue scar. Some of the sutures were still *in situ*.

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CONGENITAL ARTERIOVENOUS COMMUNICATIONS¹

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ABNORMAL communications between arteries and veins may be divided into two groups: congenital and acquired. The latter are the result of trauma, often in the form of stab and bullet wounds, and form the majority of such conditions. The former are rare and therefore all the more interesting; there is no history of trauma, but they manifest themselves at birth or at a varying time afterward and run a progressive course. Callander in 1920 published a comprehensive review of the literature on arteriovenous fistula, collecting records in all of 447 cases, beginning with that described by William Hunter in 1757. He found that 383 of the cases were due to trauma, that in 34 the etiology was unknown, and that the remaining 3 were of congenital origin; these being reported by Bushe, Hewett, and Halsted. One realizes of course that cases of the congenital type are probably not so rare as the paucity of the number of recorded cases would lead one to suspect; many no doubt having escaped report in the literature. Callander's review shows well the preponderance of cases of the acquired type, usually found

Bushe's patient was a girl aged 7 years and 7 months, presenting a purple pulsating tumor about 2 centimeters by 1 centimeter in the region of the right temple. The tumor had existed and gradually enlarged from birth, and for the 3 months prior to examination had been attended by hemorrhage. While pressure was being made on the carotid vessels, Bushe removed the tumor with a few quickly executed sweeps of a scalpel. With pressure on the carotid released, almost the whole of the raw surface spurted blood, the hemorrhage being controlled at first by the actual cautery, though eventually ligation of the external carotid was necessary.

In the case reported by Hewett, the patient was a girl aged 17 years, whose right thigh

from birth had been larger than the left. As long as the patient could remember she had had a peculiar beating in the affected limb. At first the swelling was confined to the thigh, spreading later to the leg and finally involving the foot. The report says that hydrocephalus was present in infancy (evidence of a concomitant congenital anomaly). Examination showed the right lower extremity much enlarged and 5 centimeters longer than the left; the superficial veins were large and tortuous, although quite soft and easily emptied of their contents. In the enlarged femoral vein a distinct vibratory thrill could be felt and traced upward to the juncture of the two iliac veins, where it ceased. A loud, continuous blowing sound could be traced up the vein to the same spot. There was a loud systolic murmur at the apex of the heart, but the size of the organ was not mentioned. Hewett's treatment consisted in placing harelip pins under all the veins he could see and compressing the vessel by twisted sutures placed under the pins, which were allowed to remain in place 8 days. The treatment was not successful and the patient was dismissed *in statu quo*. Hewett believed that an arteriovenous communication existed on the right side between the common iliac vessel at their point of crossing.

Halsted's case of much more recent date was a girl aged 11 years with a throbbing swelling in the right side of the neck. A throbbing and buzzing were discovered days after birth, but an actual swelling was not observed until the ninth year. At operation a fistula was found between the external carotid near its origin and one of a mass of greatly dilated vein. Great dilatation of both common and external carotid arteries was noted, whereas the internal carotid was surprisingly small. The heart was normal and even in rhythm. At the time of a second

operation $6\frac{1}{2}$ years later there were no signs or symptoms of cardiac involvement

The most recent cases of congenital arteriovenous fistula were reported by Reid (16) a former pupil of Halsted. There are 6 in all including that of Halsted. Reid having had occasion to perform an operation on the patient $6\frac{1}{2}$ years after his former teacher. The situations of the lesions in the 5 new cases were as follows: the left lower eyelid, the right subclavian and transversalis colli vessels, the left anterior tibial vessels, the right cerebral vessels and between the internal carotid artery and the cavernous sinus. Thus 4 were in the head and neck and 1 in an extremity.

We are reporting here 9 additional cases of congenital abnormal communications between arteries and veins which have been seen at the Mayo Clinic since 1916. We were able to carry out detailed clinical studies in Cases 3, 5 and 8.

REPORT OF NEW CASES

CASE 1. A girl aged 23 years had been troubled since birth by a bunch of bluish dilated veins over the right occipital and temporal regions. Trauma apparently aggravated the congenital condition for after the age of 10 years when she was struck by a stone near the dilated veins these began to enlarge and the dilatation gradually extended downward into the neck.

A large mass evidently of pulsating veins was seen over the right lateral aspect of the head and the right side of the neck (Figs 1 and 2). There was a loud bruit audible throughout the mass and a marked thrill just in front of the ear. The systolic blood pressure was 116 and the diastolic 90; the pulse rate was 84. A systolic murmur was heard at the apex of the heart but there was no enlargement of the organ.

The first operation was performed August 3, 1916. Arteriovenous anastomosis was found on the right side of the neck and on the scalp extending to the median line in the parietal and occipital regions. Distinct pulsation was evident throughout the entire mass. The largest vein in the neck was apparently the external jugular which extended down over the sternum and reached the median line. This vein was about 5 centimeters in diameter. Ligation of the external carotid stopped pulsation in the entire mass. The veins of the neck were excised.

At a second operation August 11 the incision was carried from the front of the ear up to the median line and over the occiput. A flap was turned back and circled vessels dissected out. Some of the vessels were ruptured during the operation and a great deal of hæmorrhage ensued. A slight amount of pulsation



Fig. 1 (left) Dilated veins of right side of head and neck (Case 1)

Fig. 2 Head shaved showing mass of dilated veins in scalp (Case 1)

was observed in the vessels at this operation. The patient recovered from the operations but died about 2 months later from bilateral pulmonary emphysema and bronchopneumonia.

CASE 2. A girl aged 10 years complained of prominence of the eyes. Nothing abnormal had been noticed until she was about 4 years of age when the right eye appeared more prominent than the left. This prominence had become more noticeable as time went on.

There was some degree of exophthalmos of the right eye. Large subcutaneous dilated veins were visible above the inner canthus and the medial half of the eyebrow. The eye could be pushed back $\frac{1}{2}$ inch into the orbit and the swelling about the medial part of the eye could be easily reduced by pressure. A typical arteriovenous thrill and murmur could be felt and heard over the veins. The systolic blood pressure was 115 and the diastolic 74; the heart was normal.

At operation February 12, 1918 the right external carotid artery was ligated. The exophthalmos, pulse and thrill disappeared and the patient has not had further trouble.

CASE 3. A man aged 20 years had been born with the right arm larger than its fellow (Fig. 3). The condition did not cause symptoms until he was 11 years of age when he began to have spells during which the arm became swollen and painful with accompanying general malaise. After the second spell the wrist and fingers became ankylosed and suppurative of the middle finger ensued. The patient first came to the Mayo Clinic in 1919 when the right arm was seen to be of greater girth than the left, also exceeding it in length by 12.5 centimeters. A pronounced arteriovenous bruit was heard in the palm and also in the clavicular region of the right side. Roentgenogram of the hand showed destructive arthritis of the proximal ends of the metacarpal bones.

TABLE II—SURFACE TEMPERATURES OF UPPER
EXTREMITIES IN CASE 5 MAY 17 1925
ROOM TEMPERATURE 38 DEGREES C

A	Temperature Left	Temperature Right
Tip of third finger	30.9	30.8
Tip of thumb	31	31.0
Knuckles	31.5	30.1
Dorsum of wrist	31.5	30.8
5 cm above wrist	31.7	30.5
15 cm above wrist	33.3	30.5
10 cm below elbow	33	31.0
5 cm above elbow	32.7	31.8
15 cm above elbow	33.3	31.5
10 cm below shoulder	33.3	31.3

There was atrophy and gangrene of the distal phalanx of the little finger. An arteriovenous aneurism of the right ulnar artery and vein just distal to the annular ligament was excised and the artery proximal to the aneurism was seen to be enormously dilated its diameter being about 2.5 centimeters. The radial artery was exposed and found to communicate with a large vein in the anatomic snuffbox both artery and vein were ligated. The amputated little finger was also amputated at this time. In 1923 ulceration of the index finger took place although there was no history of trauma and gangrene ensued. The patient returned and the finger was amputated. He became gradually worse and the right hand became a direct hindrance to him. In 1925 dry trophic ulceration appeared at the site of amputation of the index finger and on the middle finger.

Numerous large dilated tortuous and pulsating veins were seen on the forearm and dorsum of the right hand being more marked on the medial side (Fig. 4). A thrill was felt and bruit heard as far proximally as the middle of the arm. The right arm was 1.25 centimeters longer than the left and averaged between 4 and 5 centimeters more in circumference than the left. The systolic blood pressure was 120 and the diastolic 80. The pulse rate was 85. The heart was markedly enlarged the apex downward and to the left and a marked systolic thrust was seen over the lower part of the precordium. There was a systolic murmur over the base. No signs or symptoms of cardiac decompensation were present.

There was marked difference in the surface temperature of the two upper extremities (Table II) the right arm being the hotter.

Table I shows as in the previous case that the venous blood in the neighborhood of the arteriovenous communication contained so much oxygen as to be almost arterial.

Amputation was performed through the forearm. During the operation the bleeding from the numerous dilated veins was like that from arteries.

Dissection of the amputated part disclosed dilatation of both arteries and veins and multiple fistulae between them (Figs. 6 and 7). The condition is well shown by roentgenographic examination after the injection of a solution opaque to roentgen rays.



FIG. 4 (above) Dilated and tortuous vessels on dorsum of hand and forearm (Case 5)

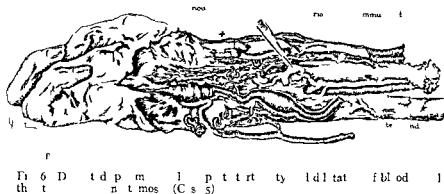
FIG. 5 Amputated arm after injection of barium solution (Case 5)

(Fig. 5) The solution returned almost immediately through the cut ends of the vessels and after it had congealed a roentgenogram was made. It is of interest to note that while the solution fills the dilated proximal arteries and veins the more distal vessels are only partially filled because of the short circuiting due to the fistulous communications.

Since the operation the local physician reports that the patient's condition is excellent.

CASE 6 A man aged 4 years came to the Mayo Clinic in 1912. Ever since he could remember his right foot had been larger than the left. In 1909 an ingrowing great toe nail of the right foot was operated on. It became infected and for 4 years constantly drained pus the toe eventually turning black. In 1913 there was a sudden hemorrhage from the dorsum of the right foot near the metacarpophalangeal joints the bleeding was stopped by binding the foot. The great toe was amputated in 1914 and since that time there had been several hemorrhages. The patient had noticed that the right foot was much swollen and he felt pulsations in the foot, leg and thigh. An ulceration on the dorsum of the right foot still persisted. A year before the patient's admission to the Clinic the foot was operated on and the anterior and posterior tibial vessels were probably ligated.

All the superficial veins of the right leg were greatly dilated (Figs. 8 and 9). The great toe was absent and there were chronic ulcerations on the dorsum of the remaining toes. Thrills and bruits were present from Poupart's ligament distally as far as the toes. The right foot felt like a mass of spongy tissue. Pressure over the internal saphenous vein immediately caused the foot to swell. There was a loud blowing systolic apical murmur and the lesion of the heart was diagnosed as chronic mitral endocarditis with regurgitation (as the patient gave a history of previous rheumatic fever the condition of the heart



could not be attributed to the adverse effects of the state of his leg.) Roentgenograms of the heel did not show enlargement. The bone of the foot were normal by roentgenogram. The systolic blood pressure was 30 and the diastolic 70; the pulse rate was 80.

At the first operation, May 4, 1926, the anterior tibial artery and the veins on the drum of the foot were ligated. The tery just proximal to the trverse curvature ligament as ligated to a diameter of about 3.7 centimeter and it was markedly thickened. The arteriovenous communications could not be located definitely.

At the time of the second operation on July 10, the but and thrill still extended above the popliteal space; the leg was amputated in an attempt to preserve a useful stump. All veins were markedly enlarged some to a diameter of 3.5 centimeters.

The patient was examined August 16 and the condition of the leg found to be satisfactory; the veins were not enlarged as before the operation and no thrill could be felt or but heard.

CASE 7. A woman aged 43 years came to the Mayo Clinic January 6, 1933. Twenty-five months before she had noticed a swelling on the chin; the swelling had gradually enlarged and for a while had a bluish tint which it appeared later. There had been no associated pain.

There was a pulsating regular tumor on the chin to the left of the median line and extended downward so as to encroach on the submental region. The tumor measured approximately 7.5 by 5 by 3.5 centimeters. It was soft and a definite thrill was palpable. The systolic blood pressure was 18 and the diastolic 8; the pulse rate was 88. The heart was normal.

Operation performed January 30. The left external carotid artery was ligated and the size of the tumor and the force of its pulsations were immediately reduced. The right external carotid was ligated February 16. The neuroma dissected and several dilated veins ligated. February 13.

November 4, 1935, the patient returned with a recurrence of the nasal lesion. She said the tumor had continued to enlarge during the last 4.5 months. At operation November 1, a pulsating indefinite mass about 4 by 3 by 2 centimeters in size

which lay superficial to the anterior belly of the digastric muscle was removed. There was a moderate amount of bleeding. The pathological report was hemangioma.

The patient returned in May, 1926, with slight fullness on the right side of the chin; a light thrill was perceptible. Radium treatment was applied.

CASE 8. A girl aged 16 years came to the Mayo Clinic to have the condition of her left foot investigated. Her mother stated that from the time the patient was a baby the left foot had not seemed quite normal and when the child reached the age of 8 years this foot had seemed to be hotter than the other. Three years later small sores began to appear on the dorsum of the toe gradually increasing in size and accompanied by a discharge of greenish pus. Because of the spread of the ulcerous area the ulcers were amputated in March, 1924. The girl was told at that time that she was suffering from tuberculosis of the foot. On account of a similar condition of the great toe the remaining digit was amputated the following November.

All the toes of the left foot had been amputated the tumor swollen, cyanosed and extremely malodorous; the distal ends of the toes were black.

History of the disease since the first operation (Fig. 6). The foot was unlikeliest to return to the normal malleolus was an area about 3 centimeter diameter over which a distinct thrill synch with the pulse was palpable. On the dorsum of the foot a malar thrill could be felt; a larger one on auscultation over these areas; a loud continuous bruit with exacerbations corresponding to the systole of the heart. She had this bruit although of maximal intensity over these areas could be heard so faintly as the middle of the calf. The legs were equal in length. The heart was normal and the first mitral sound was accentuated. The stethoscope pressure was 120 and the last lie 8. The pulse rate was 80. Roentgenographic examination of the foot showed that all the toes had been amputated through the middle of the metatarsal bone and lesion of the bones was not discernible.

Clinometric studies made with the Stearns Kege's foot caliper to determine the heat emission of both feet (Table III).



Fig. 7 Dorsal aspect of dissected specimen shown in Figure 6 (Case 5)

It will be seen that the left foot was emitting nearly 12 times as much heat as the right

Table IV shows that from the knees downward the temperature of the left leg became progressively higher than that of the right the maximal difference was attained at the heel 5.2 degrees C (8.6 degrees F)

In this condition one would expect to find the oxygen content of the venous blood in the vicinity of the arteriovenous communication varying greatly from normal (Table I). Thus the venous blood from the affected (left) foot contained more than four times as much oxygen as that from the right and consisted of nearly pure arterial blood. The total volume of whole blood was found to be 106 cubic centimeters for each kilogram of body weight

June 26 the dorsalis pedis and posterior tibial arteries in the left foot were ligated. In consequence of this procedure the foot appeared to improve for a short time. July 7 it was seen that the total volume of whole blood was 88 cubic centimeters for each kilogram of body weight this was a marked decrease. After a few weeks the foot began to cause pain again and the scab covered sinus at the distal end of the foot did not show any signs of healing. The patient returned and the foot was amputated.

Pathologically this seems to be a case of multiple aneurismal varicose or cirroid aneurism

TABLE III—CALORIMETRIC STUDIES OF BOTH FEET SHOWING THEIR MARKED DISSIMILARITY OF HEAT EMISSION CASE 8

Date	6-18-5
Blood Pressure	
Systolic	120
Diastolic	80
Pulse	80
Temperature (C)	
Outdoor	24.2
Room	23.8
Right foot	
Total calories for 10 minutes	680
Surface area (square inches)	9
Calories for each minute for each square inch	0.73
Left foot	
Total calories for 10 minutes	7100
Surface area (square inches)	82
Calories for each minute for each square inch	8.65

CASE 9 A boy aged 6 years was first seen in June 1921. He was quite well until the previous November when the parents noted slight puffiness of the left upper eyelid. Shortly afterward they noted pulsation in the region of the inner canthus and then a distinct bruit over different parts of the head.

The patient was well nourished. There was slight exophthalmos of the left eye with some congestion of the conjunctival blood vessels. Pulsation was visible and a bruit of maximal intensity over the left temporal area could be heard over the whole skull. Pressure on the left common carotid artery reduced both thrill and bruit considerably. The heart was normal. The systolic blood pressure was 108 and the diastolic 5 the pulse rate was 98. Examination of the fundus disclosed bilateral choked disc. At operation July 1 the left common carotid artery was ligated just below its bifurcation. In May 1933 there was no marked change in the patient's condition the exophthalmos pulsation and bruit still persisting.

The main points of interest in the nine cases are summarized in Table V.

ETIOLOGY

The studies of Sabin and Woollard appear to explain the occurrence of these arteriovenous communications on an embryological basis since both arteries and veins arise through differentiation from a common capillary plexus. Sabin finds that in certain embryological vessels the direction of the flow of

TABLE IV—SURFACE TEMPERATURE OF FEET AND LEGS MEASURED AS FAR AS POSSIBLE OVER CORRESPONDING AREAS JUNE 17 1925 ROOM TEMPERATURE 23.8 DEGREES C

	A	Temperature	
		Right	Left
Heel		5.6	30.8
Dorsum of foot		27.5	32.3
10 cm intervals proximally			
	1	29.2	32
	2	29.3	31.9
	3	30	31.4
	4	30.5	31.8



Fig 8 (b) Distal phalangeal development
 lc t ft (C 6)
 I b 9 I e p t f l g h a g l l t d
 (Ca 6)

blood may be reversed so that these vessels which function as arteries during one stage of development function as veins during another she mentions the subintestinal artery and the vena capitis medialis as examples. Woollard's diagrams show clearly the capillary network through which the forelimb bud of the pig embryo first gets its blood supply and how at a later period when the subclavian artery and vein are beginning to be differentiated there are multitudinous communications between the two vessels. Because of this state of affairs existing in the embryo Reid (17) aptly expresses wonder that congenital communications between arteries and veins do not occur more frequently.

This embryological explanation also satisfactorily account for the multiple communications usually found in congenital cases in contrast to the single communications usually present when the etiological factor is trauma. It is interesting that Reid in his congenital case of arteriovenous fistula between the subclavian vessel found that the artery and vein were each connected with the intermediate mass of dilated veins by a single vessel.

SITE OF OCCURRENCE

Whereas an acquired arteriovenous fistula may be situated anywhere in the body depending on the part traumatized congenital cases are somewhat more limited in their distribution the vessels of the trunk apparently being only rarely if ever affected although

Hewett diagnosed the lesion in his case as intra abdominal. This is the only example of the congenital type affecting the vessel of the trunk which has come to our notice. An analysis of our cases shows the site of occurrence to be head 3 (scalp) 2 intracranial 1) neck and extremities 4. Of Reid's 5 case 4 were in the head and neck (intracranial) and only 1 was in the extremities. It would seem therefore that the commonest sites of occurrence of congenital arteriovenous fistulae are the head both extracranial and intracranial and neck while the extremities come next in order of frequency.

THE EFFECTS OF ABNORMAL ARTERIOVENOUS COMMUNICATIONS

The usual effects of arteriovenous fistula in general may be considered from three aspects (1) local (2) regional and (3) general or systemic.

The local effects are those manifested by the affected blood vessel. The blood from the artery flows into the distal part of the vein greatly increasing the volume of blood in it and producing a pressure greater than the vein is normally capable of withstanding. As a result the vein becomes dilated and tortuous. Similar changes take place though probably not to such a great extent in the proximal part of the vein. The larger the fistula and the longer its duration the more widespread will be the venous involvement in many cases almost all the veins of a limb which is the site of a fistula being affected. Reid (15) found in experiments on dogs that there was an increase in the elastic tissue in the wall of an involved vein (the so called arterialization). We were able to examine microscopically the vein in the vicinity of the anastomosis in one case only. We found no evidence of arterialization but calcareous degeneration was well marked in the internal part of the middle coat in one section (Fig 11).

The effect of an arteriovenous fistula on the involved artery consists of dilatation thinning of its wall and degenerative changes in its coat. All these changes taking place in greater or less degree only proximal to the fistula. Holman (1) has drawn attention to

the fact that when the cross section of the fistula is small these changes may be hardly noticeable or even entirely absent although the fistula may have existed for many years whereas when the fistula is large they are invariably present particularly the dilatation and thinning in marked degree. As to the cause of these changes in the proximal artery opinions are somewhat divided. Some authors believe that the diminished blood pressure causes loss of tone and functional inertia which results in the changes just described. The objection to this theory is that the diminished blood pressure is general and since other arteries are not affected it would seem that the cause is local rather than general. Others take the view that the increased amount of blood flowing through the artery is sufficient to account for them. Reid (18) thinks that it would be unusual if a simple handling of an increased volume of blood by the proximal vessels did not lead to an hypertrophy and strengthening of their walls. While it is true that dilatation thinning and degeneration of the walls of the hollow viscera are often the sequelæ of previous hypertrophy yet this is not always so and we offer another explanation of these changes. In the first place the dilatation is acute in support of this are the observations that it is present only when the fistula is large and that it occurs almost at once after the production of the lesion. Second the dilatation causes constriction of the *vasa vasorum* and thus results in diminished nutrition of the vessel wall leading finally to thinning and degeneration.

The regional effects are those evident in the particular limb affected. The first is hypertrophy as seen in the increased girth and length of the limb. The latter indicates an overgrowth of the bones and is found only when the lesion has been established for some time before the ossification of the epiphyseal cartilages so that congenital cases are particularly liable to show it. The second effect is increase in superficial temperature and the third trophic changes. The first two can be explained by the increased volume of blood flowing through the limb consequent upon the production of the fistula. The trophic changes are produced by two factors first



FIG. 10. Left foot, hospital amputation of toes and calcaneus, discharge in sinus (Case 8).

the diminution of the flow of blood through the capillaries on account of its easier path of escape into the veins through the fistula and second the increased pressure on the veins impeding the return of deoxygenated blood from the capillaries. These two factors working together tend to bring about a state of anoxia of the tissues affecting more particularly those most distally situated. On this account if these tissues become even slightly injured the normal inflammatory reaction necessary for their repair is either feeble or absent and hence chronic progressive ulceration (partial destruction) and later gangrene (total destruction) supervene. In Cases 3, 5, 6 and 8 that is all those in which an extremity was affected chronic ulceration and gangrene were quite prominent features.

The general or systemic effects depend on the upset in the function of the circulatory system produced by the development of the fistula and also on nature's efforts at compensation. Normally the circulatory system consists of heart, arteries, capillary bed and veins. The formation of an arteriovenous fistula creates a new path through which the

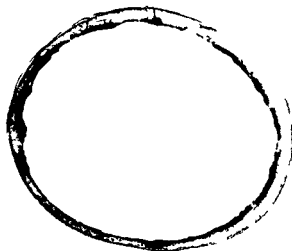


Fig. 1. A. N. Sh. N. Calc. reo. s. d. e. t. o. n. e.
p. t. of m. d. d. l. c. t. (C. 5)

blood can flow a second system consisting of heart artery fistula and vein being thus formed. The essential point of difference between the two systems is that the second (fistulous) system is practically devoid of peripheral resistance. Since a fluid will always flow along the path of least resistance the less the peripheral resistance of the fistulous system the greater will be the tendency for blood to pass through it. In order that blood may still continue to flow through the capillary system with its high peripheral resistance it is essential that an adequate general blood pressure should be maintained (Holman 7).

The systemic effects may be considered from three aspects: (1) peripheral resistance and blood pressure (2) total volume of circulating blood and (3) the reaction of the heart.

While systolic pressure is chiefly maintained by cardiac output diastolic pressure on the other hand is largely maintained by the elastic recoil of the arteries against the peripheral resistance. Following the production of a fistula the peripheral resistance is much diminished. Thus in arteriovenous fistula one would expect a normal or nearly normal systolic pressure and a low diastolic pressure with consequent increase in pulse pressure. These are usually found particularly in cases of the traumatic type. In our 9 congenital cases a low diastolic pressure was noted only

in 3 (Cases 3, 5 and 9). On closure of the fistula (and therefore reestablishment of the normal peripheral resistance) the diastolic pressure rises to normal while the systolic pressure usually remains about the same although there may be a transient rise. Hoover and Beams reported that on closure of the fistula the systolic pressure rose by the same amount as the diastolic but in most of the reported traumatic case the systolic as already mentioned remains the same or rises only a few points. As multiple anastomoses are present in congenital case these changes in blood pressure are difficult or impossible to elicit because of the difficulty of closing all the fistulae simultaneously.

Holman has pointed out that because of the easier path of escape offered to the blood from the arterial system by an arteriovenous fistula the amount of blood passing through the system heart arteries capillaries and veins is reduced according to the size of the fistula that in order that the supply of blood through this system will be sufficient for the need of the body an adequate general blood pressure must be maintained and that one of the compensatory mechanisms to insure this is an increase in the total volume of the circulating blood. He proved his theory to his complete satisfaction by experiments on dogs in which he had produced arteriovenous fistulae showing that when the lesion was small (and therefore the amount of blood short circuited back to the heart was correspondingly small) the blood volume remained constant or nearly so while with larger fistulae he found a definitely increased blood volume together with changes in the heart and proximal vessels (9). Even admitting that the present method for the determination of blood volume leaves much to be desired his results seem definite enough to be outside the limits of experimental error.

From a comprehensive study of blood volume (by the dye method of Keith, Iowntree and Geraghty) in health and disease Brown and Rowntree do not regard the results obtained by present method of estimation as absolute but believe that for comparative work they are reliable. They have found that blood volumes between 70 and 100 cubic

centimeters for each kilogram of body weight may be regarded as normal for different healthy individuals. On the other hand the blood volume in the same healthy individual estimated at different times under comparable resting conditions may vary as much as 5 cubic centimeters for each kilogram. The single case in our series (Case 8) in which the blood volume was determined before and after operation showed a fall from 106 to 88 cubic centimeters for each kilogram of body weight after ligation of the main arteries involved, a decrease greater than the normal variation. This single piece of clinical evidence though supporting Holman's experimental results does not justify any definite conclusions being drawn. However we hope in due course to have the opportunity of studying blood volume in a sufficient number of cases to be able to satisfy ourselves as to whether the data in this single case can be satisfactorily corroborated or not.

In many of the cases reported in the recent literature on the subject enlargement of the heart has been noted sometimes accompanied by symptoms or signs of myocardial degeneration. Until comparatively recently it was thought that the heart condition was coincidental and that if the state of the heart was poor the surgical risk was correspondingly great and operation contra-indicated. During the war however observers had the opportunity of studying a large number of cases and they began to recognize that the condition of the heart was not coincident with but consequent on the production of the fistula. One of the most striking cases is reported by Leriche. This surgeon extirpated an arteriovenous aneurism in a patient in whom considerable cardiac enlargement and general signs of cardiac decompensation were present the heart returned to its normal size and the signs of decompensation disappeared. This case together with later abundant experimental work and clinical investigation by the Americans Holman (7, 8, 9), Matas, Reid (15, 16, 17, 18, 19), Hoover and Beams and the Englishmen Lewis and Drury has completely proved the detrimental effect of abnormal arteriovenous communications on the heart. Opinions differ as to the cause of the

cardiac enlargement. Lewis and Drury maintain that it is largely due to dilatation consequent upon faulty nutrition of the myocardium the low diastolic pressure being insufficient to permit of adequate filling of the coronary vessels. On the other hand Holman (8) in experiments on dogs found that in addition to dilatation there was an increase in the weight of the heart which he concluded must be due to hypertrophy. In our series cardiac enlargement was only demonstrable in 2 cases (Cases 3 and 5). It did not occur in any of Reid's cases.

An arteriovenous fistula has been described as analogous to an aortic leak but whereas in aortic regurgitation the left side of the heart alone undergoes dilatation and hypertrophy as a compensatory measure in arteriovenous fistula both sides of the heart undergo these changes the right side on account of having to cope with the increased intake consequent on the abnormal escape of blood into the veins through the fistula the left in order to increase output to maintain adequate general blood pressure. If Holman's contention be correct in addition to these factors the heart has to deal also with increased total volume of blood.

Branham in 1890 noted that in these cases closure of the fistula produced slowing of the pulse rate this observation has since been spoken of as Branham's bradycardiac phenomenon. It could not be elicited in any of the congenital cases in this series because of the difficulty in closing the multiple communications. When an arteriovenous fistula is closed the blood has to flow through the circulation heart arteries capillary bed and veins so that the peripheral resistance of the arterioles is again brought into play with resulting increased peripheral resistance and consequent raising of the blood pressure. The slowing of the rate of the heart is therefore in accordance with Marey's law that the pulse rate varies inversely with the blood pressure. The mechanism by which the pulse rate is adjusted in this manner has long been regarded as reflex it being thought that a rise in blood pressure by stretching the wall of the aorta stimulates the endings of the depressor nerve as a result of this the cardio-inhibitory center was thought to be excited and that the impulses

TABLE V.—CLINICAL MANIFESTATIONS AND TREATMENT OF CONGENITAL ARTERIOVENOUS ANEURISM

C	S	Les	E d d f h g	Blood p es			T ph b ges	D i fop	Typ f pe	D i d p um l ry	Res lt	R m k
				P i	6	8						
3	F	C so d ght d d k f h m	by t l m m t p	84	6	8	N	8 3 5	L a l f ght d	-		R d f m d p l l t h es b m
1	I	A m b d	N		5	7		8	L l f h t d	-	W ll	
VI		A m bcl b l f es l	H l ged				R b ll m d by p h ma & j g g m	6 9- 9 0	Lug f ht l L d l f ugh	+	N fi be fi	G l l fi g f l h R gh m mp ted b h ld F b ry s (be h
M		C so d lp ism f	N				N		D ssec f m	-	C ed	
3	M	A so m right f d yp v		8	R bt s L ft 60		H p phy f m h	-6-	E f mm b w y d	+		A gr hy d g l h l g l ees f l mp f f P box m kedl encl edl dum
6	I	A m f igh foo	Lef l hype l phy d m l l	8		7	L l do ugh foot	5 0-	Lug y f b l Am f m m idl	-	W ll	
7	F	S bn l m so d	N	9	5	78	N	30-4 6-3 3 3 5	L l f l l d L ga l f ugh id D ssec f ism D ec m f	- - - -	W ll	Th m s d m n bed l l gh p f s sa so m l
8	6	A m so d an lef foo	N	8		80	L ph f l es	6-6- 0-8-5	Lug ped b l f d sal d pos es Amputa l		W ll	
9	6	I ac anial h p ba ph halmos f l l y	o-m	9		8		7	Liga m		l gh l m ed	T y m a ked h l l so lru and rebth l mos all p ese

from this center by way of the vagi brought about a reduction of the pulse rate. In this connection we would like to draw attention to the recent work of Anrep and Starling which seems to necessitate some modification of this view of the reflex causation of the phenomena on which Marey's law is based. In the experiments they used a method in which by means of a heart lung preparation the circulation through the brain of an animal is entirely under the control of the experimenter while the animal's own heart supplies only the trunk and limbs. By such an arrangement the circulation through the vasomotor and cardio-inhibitory centers is entirely unaffected by changes in the action of the heart or in the circulation through the trunk and limbs. The nervous connections between the brain and the heart of the same animal were undisturbed. It was found that when the pressure in the brain was raised the heart was slowed if both vagi were intact but not if they were divided but rise of blood pressure in the animal's own aorta caused no such reflex alteration in the rate of the heart beat whether the vagi were intact or not. The slowing expressed as Marey's law therefore would seem to be explicable not by reflex through the fibers of the depressor as has been commonly supposed but by the direct effect of the raised arterial pressure on the cardio-inhibitory center.

In cases of arteriovenous fistula the diastolic pressure is lowered while the systolic is practically unchanged thus the mean arterial pressure is lowered. This no doubt accounts for the increased pulse rate observed both clinically and experimentally in these cases in accordance with Marey's law. A pulse rate above 80 was noted in 5 of our cases (Cases 1, 3, 5, 6 and 9).

TREATMENT

Surgery provides the only effective treatment of congenital arteriovenous aneurism. In order to treat successfully any arteriovenous aneurism the abnormal communication or communications between the arterial and venous circulation must be permanently broken. To accomplish this the fistulous tract must be destroyed by excision or division or its lumen obliterated as by ligation or clotting or the

fistula or fistulae including segments of the adjacent arteries and veins must be isolated from the circulation as by multiple ligation of the artery and vein.

There are reports of numerous cases of traumatic arteriovenous aneurism both experimental and clinical in which spontaneous clotting and subsequent healing have occurred under non-operative management. Nearly all of these aneurisms have a small fistulous tract and are of recent development usually within 2 or 3 months but there is no justification for non-surgical measures in any case of arteriovenous aneurism which has lasted 6 months or longer in the reasonable expectation of causing the fistula to heal. In the congenital arteriovenous communications success from non-surgical measures such as injections of anticoagulants, cautery puncture and irradiation is limited to the occasional small nevus or pulsating hemangioma. In all others cure is effected only by radical surgical measures.

In the main the symptoms of congenital arteriovenous aneurism are similar to those of the traumatic type yet the treatment of the former presents inherent problems that are not often encountered in the acquired aneurism. The additional difficulties in treatment arise from the differences in the pathological anatomy. In the traumatic type the communication established in most cases by a penetrating wound is usually single and often involves the larger vessels accessible to surgical approach. Here the problem is restricted to checking the arterial leak without interfering with the blood supply of the tissue beyond. With the diversion of part of the arterial blood through the leak the blood supply of the tissues distal to the fistula becomes impaired. Collateral circulation is thereby stimulated and invariably becomes well established so that the choice of any of the several accepted operative procedures may be selected usually without fear of gangrene of the extremity.

The operative procedures which are of approved worth in the treatment of arteriovenous aneurisms include (1) excision of a segment of the affected artery and vein including the fistulous tract (2) isolation and ligation of the fistulous tract with silk (3) restorative angioplasty which may be accomplished by one of

three methods division of the fistula and lateral suture of the opening in the artery and vein the Matas Bickham transvenous method of closure of the fistula and endo aneurismorrhaphy (Matas) in certain cases of varicose aneurism and (4) quadruple ligation of the artery and vein proximal and distal to the aneurism

The operation of ligation of the proximal artery alone is mentioned only to condemn it as an obviously unsound procedure suitable for only one type of arteriovenous aneurism the intracranial lesion of carotid cavernous sinus fistula or pulsating exophthalmos. When the proximal artery alone is ligated in the case of an arteriovenous aneurism involving important vessels of an extremity the blood supplied to the parts distal to the anastomosis by way of the arterial collaterals will flow in the direction of least resistance that is in a retrograde manner through the distal artery by way of the fistulous opening back to the heart. The greater part of the collateral circulation will then be shunted back to the heart without furnishing adequate nutrition to the extremity thus trophic sores or gangrene become inevitable

In cases of intracranial arteriovenous fistula direct attack on the fistula is impossible. Experience has proved that a great many of these involving the internal carotid and the cavernous sinus particularly those of traumatic origin are ameliorated and frequently cured by proximal ligation of the internal carotid. In such instances the communicating tract must be small to favor closure by clotting. But even so it is difficult to understand how cure is effected unless it is that the slowing of the blood stream through the fistula incident to the ligation of the carotid is more marked than usual. This might be explained by the additional obstruction to the flow offered by the trabeculations in the cavernous sinus permitting clotting in the fistulous tract to occur before the secondary rise in blood pressure in the distal carotid after the reestablishment of the collateral circulation.

The one recorded case of a congenital arteriovenous aneurism with a single communication is that of Reid already referred to. In this case the difficulties entered made it

necessary to perform the operation in two stages and to apply 10 ligatures to important arteries and veins to bring about cure. However in most cases of congenital arteriovenous aneurism there are multiple communications between the arteries and veins often between the small branches. This fact materially complicates the treatment for to effect a cure not one but all of the communications must be destroyed. The treatment therefore must be directed at the extirpation of the mass of dilated vessels and their communications as in superficial circosid aneurisms or the affected limb must be amputated. In 3 cases in this series in which a limb was involved a maximal thrill could be felt over one of the larger arteries which suggested that the communication was single and an operation was advised with the view of extirpating the fistula. After exposure of the vessel a definite anastomosis between the artery and its two venae comites was found and extirpated with both artery and veins had been sacrificed. Following this procedure however in each case the circulation in the distal part was definitely diminished gangrene resulted and amputation of the limb became necessary. Subsequent radiological examination and dissection of two of the amputated limbs showed scattered diffusely through the limb numerous communications between the arteries and veins many of only minute dimension the presence of which precluded the possibility of any effectual surgical treatment of the anomaly other than by amputation.

The time to institute radical operation should of necessity vary with each patient the site and the rapidity of the growth of the lesion the degree of local disability and the presence or absence of systemic change should be taken into consideration in making the decision. It is conservative surgery to extirpate the superficial arteriovenous aneurism in early stages or extensive growth takes place otherwise radical measures resulting in mutilation or disfigurement are necessary. In the case of cardiac aneurism amputation of the limb for congenital aneurism is the only safe method of dealing with the defect. In the case of an arteriovenous aneurism of an extremity the decision is incon-

CONCLUSIONS

1 A consideration of the congenital cases reported establishes the following points of difference between them and those of the acquired type (a) there were multiple communications between arteries and veins as opposed to the single communication usually obtaining in traumatic cases (b) while the local and regional effects were similar to those found in the acquired type the general effects were not nearly so well marked and (c) the effects of the congenital form were produced much more slowly. It would seem that these last two observations may be attributed to better adaptation of the cardiovascular mechanism when the abnormal condition exists from birth.

2 The head and neck are the most common sites of occurrence the extremities coming next in order of frequency. The vessels of the trunk are rarely if ever affected.

3 On account of the frequent presence of multiple communications and the progressive nature of cases of the congenital type they are more liable to necessitate radical amputation than are the acquired cases.

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THE DISTAL ANTERIOR CLOSED SPACE INFECTION

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F m h D p tm t f S g y Th P byt H p tal dth Cl lg fPhy ds g C l mb t t

FOR many years Kanavel (3) and Auchincloss (1) have stimulated assistants and students to a better understanding of hand infections. There are many fundamental surgical principles which can be brought out while teaching the distal anterior closed space infection. Although designated as a minor surgical condition it frequently terminates as a major problem both for surgeon and patient. The discomfort, loss of time and occasional deformity which result make it evident that early recognition and proper treatment of this infection are necessary. Felon, as a synonym, has been discarded in this paper because as this term is generally used it may signify an involvement of too many other adjacent anatomical spaces or structures.

Industrial surgery has made possible the accumulation of many hand and finger cases for statistical purposes. In one insurance company (5) 65 per cent of all the hand cases were found to be due to infections following small injuries and the remaining 35 per cent included fractures, lacerations and crushing injuries. The combined statistics of 5 other insurance companies show that 15 per cent of their cases were treated for injury of the hand and that one fifth of these had infection. The latter caused 75 per cent of serious deformities of the hand (2).

In order to get certain specific data on the condition under discussion 45 consecutive ambulatory cases were studied at the Presbyterian Hospital according to a distinct scheme as seen in the accompanying table. It must be understood that accurate conclusions cannot be drawn from the statistics alone. There are so many variable factors that definite impressions acquired from experience with hundreds of other cases should not be excluded.

THE ANATOMY

A careful study of the anatomy (Figs 1 and 2) is essential to an understanding of the

pathology of this infection. The distal anterior closed space is a confined small compartment on the volar surface of the finger. It extends from the distal crease to the tip. Posteriorly it is bounded by the volar aspect of the phalanx and laterally by fibrous tissue septa which separate it from the paronychia. It contains the following structures: fat pads, fibrous tissue septa, blood vessels, nerves, sweat glands, lymphatics, periosteum and the insertion of the tendon of the flexor profundus digitorum at the proximal end of the distal phalanx. The flexor tendon sheath begins at the base of the distal phalanx and is included in the distal anterior closed space. It does not completely surround the tendinous insertion. The gland is superficial and quite numerous. Klapp and Beck (4) having demonstrated them even near the periosteum.

The fibrous tissue septa, strong penetrating connective tissue fibers, run radially and centripetally from the thick skin and corium to the periosteum. This latter is composed of two layers, an outer which has loose connective tissue fibers and an inner with a considerable amount of elastic tissue running in parallel bundle close to the bone.

The blood vessels of the inner layer are smaller than those of the outer layer and are intimately connected with the bone marrow by perforating arteries. The blood vessel enters the cortical bone through the Haversian and Volkmann's canals and anastomose with the vascular system of the bone marrow. The fibers of Sharpey (periosteal prolongation into the bone) end in the interstitial lamellae. The terminal portions of the digital arteries lying anterolateral to the distal phalanx are the primary trunks for the blood supply of the space and bone. The epiphysis receives its blood supply from a small independent volar digital branch which is given off on either side of the base of the phalanx before the main digital branch enters the closed space. The venous return from the bone marrow is chiefly through the vein emerging

from the nutrient foramen usually situated on central part of volar aspect of the phalanx.

The superficial lymphatics form a diffuse network and drain proximally into the villa Roux (6) believes that there are lymphatics which run perpendicularly from the skin to the periosteum. These have not been definitely demonstrated. The phalanx is composed of a terminal tuft which is cortical bone, a diaphysis with its medullary cavity, and a proximal epiphyseal portion which is also cortical bone.

ETIOLOGY

It must be remembered that these cases were studied in a general hospital. They were most frequent in the second and third decades and were divided about equally between the sexes. Manual laborers and housewives were in preponderance. In the vast majority of cases the patient remembered a prick in his finger from a sharp object such as a pin, a bone or a splinter. In other instances there was a history of a superficial abrasion, a cut, a slight burn or a continued contusion. Many times a trauma is not recalled.

PATHOLOGY

With the introduction of bacteria either directly or through the lymphatics the infection may be originally superficial and then spread to the deeper parts or it may take its inception in the deeper parts first. In the former case a small pustule is formed the contents of which travel along the path of least resistance perpendicularly or obliquely downward between the fibrous tissue septa and into the fat pads. After they reach the comparatively avascular fatty tissue fat necrosis takes place. In the early stage of the infection there is no free pus. Most frequently the superficial pustule and the deeper necrotic area are larger in diameter than the sinus that connects them hence the familiar name "collar button" infection (Fig. 3). The infection may start at the tip of the finger and burrow directly backward hugging the tip or volar aspect of the phalanx or it may start directly in the center of the closed space laterally or proximally. The statistics compiled from our 45 cases show that the majority of the infections occur distally.

The infecting organisms in their order are the staphylococcus aureus and albus, the streptococcus colon bacillus and as a contaminant the pyocyanus. Human bites cause a mixed infection which also yields anaerobes. Cases infected with pneumococcus, gonococcus and diphtheria bacillus have been reported (4). The reaction from these organisms is generally the same in this infection as in most parts of the body. Thus the staphylococcus is prone to produce much pus and slough while the streptococcus gives a great deal of pain with lymphangitis.

The phalanx may become involved in one of three ways: first by infection carried through the lymphatics which run perpendicular to the bone and underneath the periosteum; second by thrombosis of the blood vessels supplying it subsequent to the marked increase in pressure in the confined space; (3) by direct spread of the infection to the medulla through the nutrient foramen. The treatment of this complication to be discussed later is based on the fact that no involucrum such as is formed almost everywhere else in the body develops in this bone. Klapp and Beck (4) have expressed a thought in this connection that seems correct. Ordinarily osteomyelitis begins in the medulla and the pathological process spreads to the cortex and periosteum through the Haversian systems. In this way the periosteum is stimulated and subsequently an involucrum forms. In the distal phalanx on the contrary the periosteum is the first to suffer severely. Regeneration therefore cannot take place until the sequestrum has been removed to allow subsequent periosteal and endosteal growth.

SYMPTOMS AND SIGNS

After the introduction of bacteria into the tissues the patient usually begins to have pain within the first 24 hours. It becomes throbbing in character and usually causes a sleepless night. Elevation of the finger and hot soaks may give relief. With the breaking down of tissue the pain usually becomes less. The constitutional symptoms as a rule are not very marked. Chills and high temperature seldom occur. In the earlier stage the end of the finger is tense and subsequently there

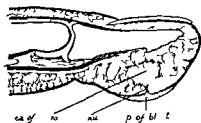


Fig 3 Scheme of a typical collar button abscess

TABLE I ANALYSIS OF FORTY FIVE DISTAL ANTERIOR CLOSED SPACE INFECTIONS

Age	N	m	b	P	C	t
Under 1	1					2
11 to 20	10				22	3
21 to 30	15				33	3
31 to 40	8				17	8
41 to 50	7				15	5
50 to 60	4				8	8
Sex						
Male	22				48	8
Female	23				51	2
Occupation						
Manual labor	23				51	06
Domestic	16				35	50
School	5				11	00
Infant	1				2	20
Type of wound						
Needle puncture	11				24	40
Unknown	10				2	0
Splinter puncture	9				20	00
Incised wound	6				13	30
Burn	3				6	60
Abrasion	3				6	60
Contusion	2				4	40
Secondary infection	1				2	20
Location of focus						
Distal	13				8	86
Lateral	12				26	64
Central	11				4	42
Unknown	5				11	00
Proximal	4				8	88
What appeared first						
Pain	35				77	80
Swelling	8				17	80
Blister					4	40
Interval time for pain						
Unknown	4				31	08
First 24 hours (immediate)	1				26	60
1 to 3 days	10				22	20
3 to 7 days	5				1	10
to weeks	3				6	60
More than weeks (7 weeks)	1				2	20
Time after pain has started that relief was sought						
3 to 7 days (most on fifth day)	5				57	70
1 to 3 days	17				37	74
10 days	1				20	
Unknown	1				2	0
X-ray findings						
Not indicated	38				84	36
Extensive osteomyelitis	3				6	66
Beginning osteomyelitis	2				4	44
No X-ray	2				4	44

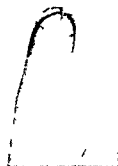


Fig 4 A half elliptical incision divided into its components—lateral bilateral and hockey stick

Inaesthesia						
General	3				71	04
Local	13				9	96
Type of incision						
Bilateral	18				39	06
Lateral	9				17	60
Horseshoe	6				13	3
Hockey stick	5				11	10
Hockey stick lon	3				6	66
Hockey stick transverse	2				4	44
Spontaneous rupture	1				2	2
Culture						
Staphylococcus aureus haemolyticus	3				17	04
Staphylococcus aureus	6				13	35
Unknown	4				8	88
Staphylococcus albus	1				2	22
Streptococcus haemolyticus	1				2	22
Gross pathological findings						
No pus	2				4	40
Few drops to 1 c cm	4				42	18
1 c cm to 5 c cm and slough	9				19	08
12 c cm	1				0	
Collar button abscess	3				6	66
Necrosis of bone	3				6	66
Involvement of mid space	2				4	44
Subungual abscess	1				2	20
Length of drainage						
48 hours	30				66	60
No drainage	4				8	80
24 hours	4				8	80
72 hours	2				4	40
3 to 7 days	5				11	1
Postoperative complications						
Most cases had none						
The most frequent is osteomyelitis						
Postoperative sequelae						
Most cases had none						
The minority had epithelial clefts						
Residual disability						
Average disability 23 days lowest 6 days longest 5 months						
End results						
Most that could be followed were good						
The others had epithelial clefts clubbing and stubbing of finger disturbances in sensation loss of substance or distortion of terminal phalanx						



Fig 5. Ca N 9 55 Ad t l t o l d p f t f th th mb b C
 N 09057 App f d t l t l d p f t th ompl t g t m l t
 6 d y ft p ton R tg m f m t s I b N t l m t f
 bo d to pph s d App of ph l of h g ft b N al t s l
 d lt ft 6 m th h g p th l l ft l f b t t bb g d cl t b
 f the fig d t f th l f R tg g m f t m l ph l f d cl h
 I ou N t t t d d l ph l p d d b v th t m t t f
 th o ly ft p t

relief for the condition is usually sought rather late. From our own statistics about 57 per cent of the cases reported for relief from 3 to 7 days after pain began and most of the others between 1 and 3 days after. A frequent error is an attempt to draw out the pus with poultices, hot soaks or the black alve (ichthyol) which the corner druggist has given the patient. Removing the top of the blister or pricking it with a needle and squeezing out pus is another common practice. Clearly with such treatment the necrotic fat pad does not receive proper drainage and if relief is obtained at all it is only temporary. An incision which is made without the use of an anesthetic is usually inadequate and causes unnecessary torture to the patient and a break in morale which is subsequently difficult to overcome.

THE PREPARATION OF THE PATIENT

The skin of the affected area is cleansed carefully and gently first with soap and water and then with lime and soda. Then follow immersion of the hand in an antiseptic solution such as potassium mercuric iodide 1:1000. Tincture of iodine applied directly is likely to obscure the field, burn the skin and cause unnecessary death of epithelium. Strict asepsis must be enforced. A general anesthetic such as gas and oxygen or ethyl chloride is to be preferred. If this is contraindicated, block anesthesia—catching the digital nerve at the base of the finger—should be used. The finger is elevated for about a minute and a rubber band tourniquet applied at its base. A clamp should always be attached to the tourniquet to insure its removal. The bloodless field produced by the tourniquet is

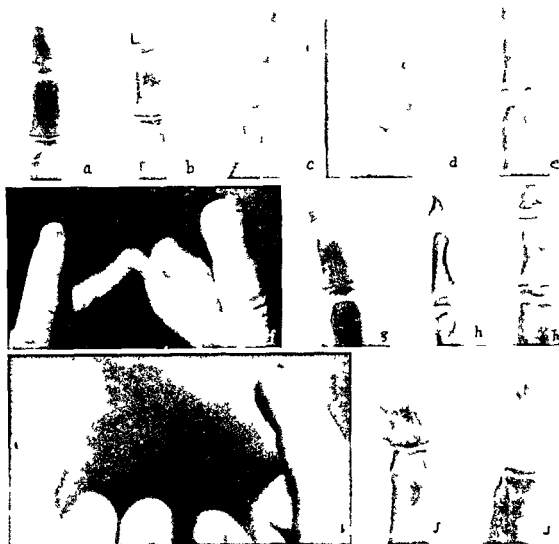


FIGURE 6. a Sequestrum at epiphysis in 7 year old boy. b Appearance of same finger as in Figure 6a 8 days after sequestectomy. c 8 days after sequestectomy. Note the increase in bone production. d 15 days after sequestectomy. e Sequestrum 15 days after sequestectomy. f External appearance of finger in Figure 6a at the time. Note clubbing and incurvation of the nail. g Appearance of finger 15 days after sequestectomy. h 15 days and one half weeks after sequestectomy. Note the unusual intact epiphysis. i External appearance of finger in Figure 6h. There is little change from condition shown in Figure 6f. j A sequestrum which was absorbed and the result after 6 months. Note the distortion of the phalanx and the absence of a rounded terminal tuft.

sential to determine the amount of pathological involvement which is a guide for the length and depth of the incision. Ethyl chloride as a local anesthetic is very unsatisfactory in this condition.

THE INCISION

The incision should cut across fat pads and fibrous tissue septa transversely so as to drain the entire area. It should be so placed as to avoid injury of a larger blood vessel, nerve or tendon sheath. A vertical incision into the infected area is hardly justifiable except per-

haps in the proximal portion of the closed space where according to Auchincloss (1) the ideal incision is more likely to injure the tendon sheath. Reference to the accompanying photograph (Fig. 4) will show a half ellipse or horseshoe which can be divided into lateral, bilateral and hook stick incisions. In all of them the entire necrotic or purulent area should be exposed. The type of incision will depend upon the extent and the site of the infection. Any incision compatible with the extent of pathology which will preclude the

TABLE II--FORTY FIVE CONSECUTIVE DISTAL

C Ag	N d	O p	Typ m p od	f hod f	d d	L f g y	Wh pp d	f b m f p	T m f p h rted l f g	Loc f loc	N d l
5 -f		f m k	P	e-p		L l	ll	h	48 h	La l	N
500 -t		hool	P	e-dl		TP	P	?	6 d y	D l	N
5 -t		ll f	P	e-edl			S ll g	h	l	D l	N
00 -l		ll k	P	e-pl		D l	P	6 d y	7 d y	D l	N
8 6-l		D m k	P	e-pl		L l	P bl f l		h	P m l	N
3 -l		M d	C	h k f		T f f	P ll d	d y	w k	E	N
		S hool	Bl	-		TP	P ll d	h	h	h	N
		hool	P	e-vl		L l	P	Imm d	h	L l	N
5 9-		k	f k f	d-		L l	P	C d b f d m I hoop l d f l		L l	N k l F m d h la
8-M		N	P	d-l		L l	P	d y	d	L l	N
0-M		l k	B			D l	P	d y	day	D l	N
00 -t		M d	P	d d-		C l	P	d	d	C l	N
-t		H k		h k f		L t l	ll	3 d	d	La l	N
0-M		P	U k w			D l	P	L k	5 d y	L l	N
008 5-M		D	P l	e-		P m l	P	d y	d y	P m l	N
00 -M		W	C -05	h fl		I	T l	d	Imm d	L l	N
00 -k		Cl k	P	d e-		D l	P	d y	6 d y	C d l	N
08 00 -M		r	-k			L l	P	5 d y	d	La l	N
4 3-t		T mm	P			La l	P	h	d	La l	N
-l		S hool	P	e-		l	P m	hou	d	C d l	N
5 -t		C k	P l	e-		D l	P m	k	3 d y	C l	N
M		Labo	P plus	e-		P m l	S ll	Immed	d y	P xmal	N
00 50-		S	C l			P m l	P m	Unkn	d	P m l	

ANTERIOR CLOSED SPACE INFECTIONS

Aesthesia	Type	Chit	Pathological findings	Type of drainage	Time of drainage	End result
Noc	Local	Staphylococ	Flap of skin	Rbb d m—48 h		
Noc	Hocky tick	Staphylococ	5 dr p f p Sl gh	Rbb Chl msky—48 h	5	
Ntr d gas d yg	P t l m d—h esh	Staphyl —ham lyt	Flap d l gh	Chl m ky bb —48 h	5	
Ntr d gas d yg	Bl t l	Staphyl	m p	Rbb d m th gh d th gh—day	4	
Ethyl hl g	Local	Staphyl	? P f l w g d y	Rbb —48 h (Rpl d t t)	48	
Noc	H h	Staphyl —ham lyt	Th k g y g p — l gh	Rbb Chl m ky—7	4	
Ntr d g d yg	H h	Staphyl —ham lyt	M h th k g p Fl p f d p ed d p tly d g t d by fec p oc	Chl m ky bb —7	8	
Nca	Local	B t t (C t m t)	C pl f dr p f g y	Slk p k g Chl m ky —48 h	3	
N	H esh	Staphylococ lb	C d bl b h p l t m t l d t bo N t gh d	Th gh l th gh p k g—7	7	
Ethyl hl g	Hocky tick	Staphyl	d p f p — f pl t	N		
Ntr d g d yg	Bl t l	taphyl —ham lyt	5 m p		35	
N	Local	Staphylococ —ham lyt	Flap	G d f m	4	S fl t
Ntr d gas d yg	Local	Staphylococ —ham lyt	Sm ll m t f p	Chl m ky bbo — d y	6	
Ntr d gas d yg	Local	Staphylococ —ham lyt	C ty—sm ll m t f p	Chl m ky bb — d y	4	
Ethyl hl g	Local	Staphylococ —ham lyt	Flap d p f p	Rbb d m—d y	8	
Ntr d g d yg	Bl t l	Staphyl —ham lyt	Sl h—sm ll m t f p	d y	7	
Noc	L g by t d d t	?	Flap	Rbb —d y	3	
Ntr d gas and yg	Local	Staphylococ —ham lyt	C d bl p — g h l gh m m t g t d p pock t	Chl m ky bbo — d y	3	
Ntr d gas d yg	Bl t l	Staphylococ —ham lyt	Mod t m t f p	Th gh d th gh bl d m—d y Rpl d y d y f t		
Ntr d gas d yg	Hocky tick	Staphyl —ham lyt cu	5 m th k h t p	Rbl d m—d y Rbb —d y		m E d f l k t l d w e th I d t d f f g
Ntr d gas d yg	Bl t l	N g th	m th k p	Rbb d m—d y	5	y S r t P t d f f g yr g l d
Ntr d g d yg	Local	Staphylococ —ham lyt cu	Flap d l gh	Rtbo —5 d y	4	m th L t t f l w p t bl
Ntr d gas and yg	Bl t l	Staphylococ —ham lyt	P d ec t m t l m	Th gh d th gh bb d m—d y	3	

TABLE II—FORTY FIVE CONSECUTIVE DISTAL

Case No.	Operative	Type of procedure	Location of lesion	White blood count	Leucocytes	Temperature	Location of lesion	Notes
8-1	W	U k	N h y	I		t	C l	5 d f p l f b d l i f h l i e s t S m f p e C m l m
100-1	I m k	P t e	C l	h l	d	l y	C l	N
100-5	W l	I	L l	I	l y	d	I l	my l p f
100-1	k	Ab	I l	I	l y	d y	I l	E k o f l p
1-1	U k	U k	U k	P	U k	J	L a d l	N
1-1	T	B	C l	S l l	l y	t	C l	N
2-1	C p	I l d f i h	L l l	P	h	d	L l l	N
1-1	f	I l d f i h	L a l	P l l	d y	d	L a l	N
1-1	H f	I l	C l	I	I t f	k	C l	N
1-1	L h o	C	C l l	P	h	d	C l	N
1-1	I m	J	I m l	P	d	I	I m l	N
1-1	H f	I	C l	P	d y	d	C l	N
1-1	I l h l	U k	L l	S l l	U k	k	C l	N
1-1	h o l	Ab	I l	l l	I	h	C m l	
1-1	h o l	U k	D f	I	U k	k	I l d l	N
1-1	l l k	U k	I l	I l l	?	5 l y	I l	N
1-1	D	Ab	C l	I	d a y	d y	I	N
1-1	C l k	U k	C l	I	t	d	C l	N
1-1	I m		?	I		l y	I l	N
1-1	C m k		?	I		5 l	C l	N
1-1	C o k		C l	I		d	I l	N
1-1	H f	P	D l	I	k	k	I l	S o m l

ANTERIOR CLOSED SPACE INFECTIONS—Continued

A th	Typ f	C li	P th l g l f l g	Typ f d d l g th g	T m l b l ty D y	E l l t
Ethyl hl de— g l	II h e	St phyl —haem lyt	m th k y h ll w p f t t f t g l m t t f t g l p	G e—3 d y	9	
Ethyl hl de— g l	II k y t k	t phyl lb	m th k y ll l gh l p t d t	R tl —9 l y		
Ethyl hl de— g l	I t	St pt haem lyt	D l k l g p d p h t t gh d R h h l j	G e—48 h	5	
Stro and yg	Bl t l l l h d y	St phyl —haem lyt	P m l l l o s d t	R bb d m—48 h	5	
N bl k	II h	St phyl —h m lyt	P S f m l t l m d l pec	R bf d m—6 d y	9	
N tro d gas	V l t l	St phyl	N p l d p th k y ll w p	R tl —d y	6	m S h m m l T gl g h f th
N tro d gas	Lat l	St phyl —haem lyt	p	R bb d m—d y	5	
N tr d y	Bl t l	St phyl —haem ly	p	R bb d m	3	m S t C ld P f l l d w f th
N tr d gas	Bl t l	St phyl —haem lyt	4 m p —	R bb d m—d y	8	6 m N mb 6 mos l htly t p t Sca
N tr d y	B l u l	N g th	dr p p	R bb d m—4 d y		
N tr d y	Bl t l	St phyl —haem lyt	m p C l bl t gh	l bb t R bb —3 l y		
N tr d gas	Bl t l	N t k	? d ps th k y ll w p	Th gh d th gh bl d bbo	3	
Ethyl hl de— g l	Bl t l	St phyl —haem ly	p	R bb d m th gh d th gh—d y	3	
Ethyl hl de— g l	B l u l	S phyl —haem lyt	m da k g h b p	Th gh d th h bbo	6	5 mos S l h t fl t t g d f f ing S m m l N mb d ld ld th
Lth	H k y t k	taphyloc —haem lyt	l m d g f p h l gh S m l l g t k t ph l	Chl m ky bbo— d y	3	m S l most bl T d 3 m th ft h ling
Stro and yg	Bl t l	St phyl —haem lyt	C l l b t bs	Th gh d th gh bb dam—d y	4	5 m N mb 3 f l ft h l g l th
Ethyl hl de— g l	Bl t l	St phyl —haem lyt	p	Th gh d th gh bbe d m—d y	6	6 m N mb 11 th l m q kly th
Ethyl hl de— g l	Bl t l	St phyl —haem ly	p	Th gh d th gh bb d m—d y	9	
Ethyl hl de— g l	H h	St phyl cu —haem ly	m p — ec	R bb h gh t th gh—d y	9	m S m ll N mb Hyposthes
Ethyl hl de— g l	Bl t l	St phyl —haem lyt	m p	R bb h gh d th gh—d y	4	
Stro and yg	Lat l g l	N gr th	N p f d	N dr	5	
F h l de— g l	II h	S phyl —h m lyt	m l q est m	Chl m ky p k—d y lod f m—l y R bb —3 d y	39	3 mos Adh t t f l t t t t G ts ld q k th th f g

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09557 os cumy lt f th d t l p l N eq lae fl l p t Cas 09075 p th l l l t

possibility of retraction of a flap or interference with sensation at the end of the finger is to be preferred. The half elliptical incision itself should be used sparingly but may be indicated for an infection which has already perforated the tip of the finger.

Free slough should be removed and if a loose sequestrum or foreign body is present it should be picked out. Klapp and Beck (4) recommend excision of the necrotic area or if this is not possible its curettage. It is preferable to wait for a line of demarcation. If this is not done tissue might be removed which has a good chance of living. The less necrosis and removal of fat pads the less will be the chance of a flattened volar surface of the finger as an end result.

DRAINAGE

Incisions should be packed widely. Where through and through drainage is used rubber dam is preferable. Removal of drains after about 48 hours is advisable. In this way subsequent painful dressings are avoided and the incision does not have a tendency to close as long as there is necrotic tissue at its bottom. In some instances an adequate incision with out drainage is all that is necessary.

THE POSTOPERATIVE TREATMENT

A dry dressing tends to control bleeding. The finger is partially elevated by means of a sling. An active arterial hyperæmia is produced as soon as possible by means of hot soaks leaving the bandage on and using either sterile saline or sterile water. The treatment is carried out every 3 to 4 hours for 15 minutes for the first 3 days. If the tissues become too macerated the number of soaks is decreased. Dead epithelium is removed as soon as possible. If adequate and proper incisions are made a narcotic is usually not necessary. A granulating surface requires the application of ordinary surgical principles to insure epithelialization.

POSTOPERATIVE COMPLICATIONS

Any of the preoperative complication may occur postoperatively and would have to be treated accordingly. Osteomyelitis of the terminal phalanx is perhaps the most frequent. Gentle removal of the sequestrum

after a complete line of demarcation has formed is the treatment. The sequestrum may be composed of cortical bone alone or a combination of cortex and medulla. In many instances a definite involvement of bone does not yield a sequestrum if adequate drainage is instituted. Under no circumstances should diseased bone be cut away.

POSTOPERATIVE SEQUELÆ AND END RESULTS

The scar as a rule becomes almost invisible and movable on the underlying structures.

An epithelial cleft is due to an infolding of epithelium in the line of incision and probably occurs more frequently if drainage has been prolonged and if the horseshoe incision has been used. With loss of tissue from the closed space and with scar tissue pulling on the edges of the incision the epithelium has a tendency to invert itself. Excision of a wedge including the cleft and approximation of the raw surfaces usually suffices to correct this condition. The major part of an epithelial cleft may be almost flattened out by continuous use of the affected finger over a period of years. Clubbing of the finger is usually associated with an incurvature of the nail and is found most frequently following an osteomyelitis. It resembles very closely a hypertrophic osteoarthropathy.

Numbness may be persistent for months or years and is usually worse in cold weather. Tactile sensation may be diminished for a like period of time. Sometimes the finger is colder and bluer than the others; this is especially marked in cold weather.

With necrosis and separation of fat and connective tissue or bone the volar surface of the finger assumes a flattened appearance. For this condition Kanavel (3) recommends a fat transplant. A stubby and shortened finger may result from sequestration even when there has been partial or almost complete regeneration of the phalanx. The latter will depend upon the amount of periosteum and medulla from which new bone growth can take place. Periosteal regeneration alone is apt to produce a minimum amount of new phalanx while under the most ideal condition the terminal tuft is very rarely found to appear again.

CONCLUSIONS

1 In order to avoid confusion the condition under discussion is best called the distal anterior closed space infection

2 The anatomy has a distinct bearing on the pathology and treatment

3 The infection is observed in a general hospital occurs most frequently in the second third and fourth decades and is about equally divided between the sexes

4 A puncture is the most important etiological factor

5 The hemolytic staphylococcus aureus is the chief infecting organism

6 Local tenderness is the most important sign

7 Complications depend upon direct extension and lymphatic drainage

8 The treatment is surgical and it is based upon the unique anatomy of the distal anterior closed space

9 A general anæsthetic is preferable

10 Diseased bone demonstrated clinically and by the X ray does not necessarily sequestrate especially if adequate surgical drainage has been obtained A line of demarcation in dead bone is the indication for sequestrectomy Cutting away or curettage of dead bone is contra indicated

11 Removal of drains after about 48 hours is preferable

12 The average period of disability is about 3 weeks

13 In cases treated early and well the end results are good An epithelial cleft clubbing and stubbing of the finger incurvation of the nail sensory disturbance and loss of substance

may result In cases in which the diaphysis of the distal phalanx has been removed or absorbed a distorted phalanx usually results with absence of a real terminal tuft

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THE ACTION OF MERCUROCHROME UPON LOCAL INFECTIONS IN GUINEA PIGS

AN EXPERIMENTAL STUDY

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THE object of this study has been to determine the relative rates of healing of focal infections in guinea pigs. Four series of animals were used: 1 set of untreated controls and 3 sets treated with mercurochrome: 20 one locally with applications of 1 or per cent of the drug; another intraperitoneally; and a third intravenously with 1 injection of 5 milligrams per kilogram of body weight.

As is well known, it is difficult to infect guinea pigs locally with the common pyogenic organisms pathogenic for man. We found, however, that by adding a small amount of neurospora in the form of a dry dough, infections could be obtained regularly with many different organisms. An incision was made about 1 centimeter in length down to the peritoneum along the midline of the shaven abdomen of the guinea pigs. By means of blunt dissection pockets were then made about 1 centimeter in width on both sides of the incision. Into these pockets small crumbs of neurospora dough were inserted and the whole lesion bathed with an 18 hour broth culture of the organism by means of a tuberculin syringe care being taken to reach the innermost borders of the pockets, but not to penetrate the peritoneum. After 48 hours of incubation abscesses had invariably formed. These were purulent and the lesion elevated from $\frac{1}{2}$ to 1 centimeter above the surrounding skin. Bacterial counts of smears of the pus from these lesions usually showed 100 or more bacteria per microscopic field; the organism inoculated predominating. However, secondary invaders were also found as no attempt was made to protect the lesions in any way. Reserving one third or one half of each group for untreated controls, the remainder were treated as desired. Observation consisted in gross examination of the lesions and in counting the bacteria in smears from the pus. The animals which received treatment had daily applica-

tions of 1 or per cent aqueous solution of mercurochrome. Intraperitoneal injections of 5 milligrams per kilogram body weight a 1 per cent solution being used were made daily. The intravenous treatment was given by exposing the external jugular which was injected with a 1 per cent solution of the drug. As a fine needle was used, ligation of the vein was not necessary. The skin incision was closed with 3 fine black silk stitches.

Eight groups of animals have been studied, excluding the 2 groups of untreated animals used to determine the course of the infection.

GROUP III. The 7 animals in group 3 were inoculated as described, the culture being taphylococcus aureus. Three animals were held as controls and 4 were given daily local applications of 1 per cent mercurochrome. One control died on the fifth day when the wound count had increased to 1000 per field. The lesions in the other control remained about the same and the count remained at 1000 per field. One of these animals became greatly emaciated and died on the fifth day. The third control showed a count of 100 until after the thirteenth day, long after the wound of the infected animals had been sterilized or healed. This third control then gradually improved and the lesion healed on the twentieth day. The treated animals all of which began with the same type of lesion, a 1 degree of infection as the control, had the first counts of 100 bacteria per field, per cent and entirely different picture. For the first 2 days the counts remained the same but on 3 of the 4 cases the lesion was much better after the first treatment and the count was still high. The lesion continued to improve steadily and all healed from the third to the fifth day of treatment. The first group dropped in the number of bacteria to 100 on the first day and on the second day to under 100 per field. From the time the day continued rapidly, the healing was complete by the seventh day. The fourth group of animals healed as completely by the fifth day as by the twelfth day.

GROUP IV. Four pigs received the same inoculation as those of Group III but a different site. Two animals were observed as controls and 2 treated locally with 1 per cent of the 18 hour broth mercurochrome. In this group the results paralleled those of Group III. The number of

organisms in the controls remained high while those of the treated animals dropped from over 100 to 5 and 15 per field after 3 treatments and then fell rapidly to zero which was reached the day after the sixth dose healing being complete on the eleventh and twelfth days (pigs Nos 12 and 13).

The count in the controls remained high and the lesions did not heal in No 15 until 2 weeks after the last of the treated animals and in No 14 although healing was complete soon after the treated animals the count remained high much longer in the control.

GROUP V Seven pigs were inoculated with the same organism and in the same way as Groups III and IV. One pig No 17 died leaving 3 controls and 3 animals which received local treatment with 1 per cent mercuriochrome. The count in No 1 remained over 100 until the eighth day. Healing was complete by the thirteenth day. The second control No 18 had a count of 100 until eleventh day when it suddenly fell off and healing was complete by fourteenth day. The third control No 20 had a smaller number of organisms throughout the infection the count remaining after an initial drop the fourth day around 20 until the seventh day when it again dropped showed a secondary rise and finally was completely healed by the thirteenth day. The 3 treated animals all began with counts of over 100 per field. No 19 dropped after the second treatment. No 18 after the first with a secondary rise. In No 16 the count remained high until the day after the fourth treatment that is the seventh day of infection when it fell off suddenly and healing was complete the fourteenth day the other treated animals being healed by the eleventh day. The treated animal had much larger abscesses than did the controls.

GROUP VI This consisted of 12 animals inoculated as before described. Four of the 6 were held as controls 4 were treated locally and 4 intravenously. The counts in the 4 controls remained up that is 100 per field. One pig No 34 died the twelfth day in great emaciation another No 3 showed pus the twelfth day with a high count and did not heal until the sixteenth day. The third control No 33 showed a drop in count the sixth day and was healed by the fourteenth day. The fourth control No 32 with a high count until the seventh day was also healed by the fourteenth day. The 4 animals which received local treatment were swabbed with 1 per cent solutions. In only 1 case No 30 did the count remain high after the first treatment and in this it had dropped to zero by the sixth day. The 3 other animals so treated No 27 No 28 and No 6 showed drops in the counts after only 1 treatment from over 100 per field to 35 21 and 2 per field respectively with a characteristic thinning of the pus which became almost watery within 4 hours of the initial treatment. The counts in these animals dropped rapidly to zero and 1 animal was entirely well by the eighth day the others showing marked improvement and final healing in 1 case on the ninth day and in the other on the twelfth. The 4 animals given intravenous treatment in this series all began with counts

of 100. In 2 cases Nos 24 and 31 the count remained high until the fifth day that is the second day after treatment in there was a drop by the day after treatment in 1 case No 5 to 25 and in the other No 9 to 4 organisms in 10 fields.

In all of the animals treated intravenously there was a typical change in the lesions consisting of a flattening out of the abscesses followed by a rapid drying and quick healing 1 being well by the seventh day and 1 by the eighth 1 by the ninth and 1 by the twelfth a better record than that shown by the animals of the same and other groups treated locally.

GROUP VII Twelve pigs were inoculated 4 being used as controls 4 given local treatment and 4 intravenously. The result closely paralleled those of Group VI. Although 1 of the controls No 41 showed a drop in the count on the seventh day and was healed by the fourteenth and another No 45 began to drop the eighth day and was healed by the fourteenth the others continued to show very high counts. Of these pigs 1 No 35 finally started to drop on the tenth day however healing was not complete until the twentieth day. The fourth control No 39 showed 100 organisms per field through the twentieth day long after the other animals were healed and the lesion did not heal until the forty second day.

Of the 4 animals in this set treated locally with daily applications of a 1 per cent aqueous solution of the drug No 35 and No 42 showed a drop in the count after the first treatment and the other 2 No 43 and 44 after the second treatment. The counts remained very low and healing was complete in No 42 by the eleventh day in No 36 and No 43 by the twelfth day and in No 44 by the thirteenth day.

The best results in this set however were obtained with intravenous treatment consisting of 1 intravenous injection of 5 milligrams per kilogram body weight. As in the locally treated pigs in 2 cases No 37 and No 46 the count fell off the day after treatment the other 2 No 38 and No 40 dropping the next or fifth day. Healing however occurred much more rapidly than in the series treated locally. No 37 and No 46 being healed by the eighth day No 38 by the ninth day and No 40 by the tenth day.

GROUP VIII Twelve pigs were infected and 4 used for controls 4 treated locally 3 with 1 per cent solution and 1 with a 1 per cent solution and 4 pigs were treated intraperitoneally with daily injections of 5 milligrams per kilogram body weight. The controls continued to show counts of over 100 bacteria per field until the eleventh day when the counts in one of them No 5 began to drop healing being complete in this case the twentieth day. Control pig No 56 healed in the same time as No 52 but its count did not begin to drop until the thirteenth day. The pigs treated locally however all showed a drop in count by the fifth day 3 being healed by the ninth day and 1 by the tenth. Of the 4 pigs treated intraperitoneally 3 showed a drop in count on the fifth day the fourth pig a drop by the sixth day. Healing was rapid No 53 being healed by eighth day No 49 by ninth No 58 by eleventh and No 50 by twelfth.

G p	P g	T m t er m d sag	Dy d co t b t per tacer scop fld												H led 7th day He l d 3 d day
			3 d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	
VIII	48	N	00	00	00	00	00	00	00	00	00	00	00	00	(C t l d d 5th d y w ll 5th day 3 ll (T fed d y) w ll th day 11 th d y 3th d y 7th 9th day)
	49	N	00	00	00	00	00	00	00	00	00	00	00	00	
	50	N	00	00	00	00	00	00	00	00	00	00	00	00	
	51	N	00	00	00	00	00	00	00	00	00	00	00	00	
	52	N	00	00	00	00	00	00	00	00	00	00	00	00	
IX	47	Loc 1	00	00	00	00	00	00	00	00	00	00	00	00	5th d y w ll 5th day 3 ll (T fed d y) w ll th day 11 th d y 3th d y 7th 9th day)
	53	Loc 1	00	00	00	00	00	00	00	00	00	00	00	00	
	54	Loc 1	00	00	00	00	00	00	00	00	00	00	00	00	
	55	Loc 1	00	00	00	00	00	00	00	00	00	00	00	00	
	56	Loc 1	00	00	00	00	00	00	00	00	00	00	00	00	

In view of the good results obtained by intravenous treatment an additional group has been studied being divided so that half of the animals were held for untreated controls and half treated with one intravenous injection of 5 milligrams per kilogram body weight of drug given on the third day after inoculation and abscess formation. In this group in which the lesions were very large 1 of the controls died on the fifth day. With the other 4 controls one was well by the thirteenth day and 3 by the nineteenth day. Of the 5 animals treated with 1 intravenous injection the counts in 3 had dropped within 47 hours after treatment and in the fifth by the eighth day. Healing was complete in the treated animals in 1 case by the tenth day in 1 by the eleventh in 1 by the thirteenth in 1 by the seventeenth and in 1 by the nineteenth. The resolution of the lesions was slower than in the other series treated intravenously but the lesions were correspondingly larger.

SUMMARY

1 Guinea pigs with abscesses have been treated with mercurochrome locally intraperitoneally and intravenously.

2 The animals treated locally as compared with untreated controls showed a prompt and rapid drop in the wound counts with healing before the controls.

3 The animals treated intraperitoneally also showed a rapid drop in counts and healing more rapid than in the sets treated locally.

4 The intravenous injection of 5 milligrams per kilogram body weight also caused a prompt and rapid drop in count in some cases quicker than in the animals treated locally.

CONCLUSION

Mercurochrome used locally and intravenously was found to be of benefit in treatment of infected wounds in guinea pigs. It was observed that healing after intravenous treatment was much better than when no treatment was employed and fully as rapid as with local treatment. Since in the animals treated locally there was obviously a much stronger concentration of drug in the lesion than could possibly reach it by intravenous injection the experiments confirm other studies showing that intravenously the drug acts indirectly as well as directly.

EXTRA-UTERINE PREGNANCY LITHOPÆDION¹

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THE term lithopædion is applied to a fetus which has been retained within the maternal abdomen and of which the tissues have become more or less completely infiltrated with calcium salts.

In the Mayo Clinic 9 lithopædions have been observed in the 24 year period from 1903 to 1926 inclusive. Eight were observed at operation and 1 was removed at necropsy from the abdomen of a woman who had died from carcinoma of the oesophagus. During this same period 445 operations were performed for extra uterine pregnancy.

LITERATURE

The literature on the subject is not extensive but it covers a period of nearly 5 centuries. In the early days the discovery within a woman's abdomen of such a hard stony mass having the form of a child excited wonder and speculation and was even viewed at times with considerable awe. Bainbridge quotes an interesting account of the first case of which we have any record. He says Israel Spach in an extensive gynecologic work published in 1557 figure a lithopædion drawn *in situ* in the case of a woman with her belly laid open. He dedicated to this calcified fetus which he regarded as a reversion the following curious epigram in allusion to the classical myth that after the flood the world was repopulated by the two survivors Deucalion and Pyrrha who walked over the earth and cast stone behind them which on striking ground became people. The epigram reads as follows: Deucalion cast stones behind him and thus fashioned our tender race from hard marble. How comes it that nowadays by a reversal of things the tender body of a little babe has limbs nearer akin to stone?

Kuechenmeister reviewed the literature from 1582 to 1880 and noted 45 cases which he believed to be authentic to the one he added of his own. He studied the 45 cases in detail and proposed a classification of lithopædions which is still generally accepted. Strauss

Bainbridge, D'Aunoy and King and others have reviewed the later literature (Table I) and we have been able to find record of 18 additional cases (Table II) not included by any of these authors making a total after deducting the duplicates of 174 cases reported in the literature from 1582 to 1926 inclusive.

In 1881 Leopold reported some experimental work to show the fate of rabbit fetuses removed from the maternal uterus and left in the abdomen. He placed embryos 5, 5 and 8 centimeters in length in the abdominal cavities of adult rabbits. In some instances he used the fetus alone and in others the entire embryo with its membranes intact. There was usually no reaction on the part of the host except in those cases in which peritonitis developed. By the second day the 5 centimeter fetuses had almost completely disappeared and by the ninth or tenth week the 8 centimeter fetuses had been reduced to a few remnants of the paws, the integument and the skeletal system. In the presence of infection the process of destruction and absorption progressed much more rapidly. If the umbilical cord was ligated absorption was slower.

INCIDENCE

The incidence in the Mayo Clinic series of 9 lithopædions in 445 cases of extra uterine pregnancy (2 per cent) is a little higher than has been previously reported. Schumann quoted the incidence at from 1.5 to 1.8 per cent but he believed the percentage to be too high. It is evident from the number of cases that have been reported that the condition is unusual even more so now than formerly because we have learned to recognize the presence of a retained fetus and to remove it surgically long before it is possible for a lithopædion to develop.

CLASSIFICATION

Kuechenmeister pointed out that calcification in the products of conception may not

TABLE I—SUMMARY OF CASES REPORTED IN THE LITERATURE

Revised by	Period	Cases
Kuechenmeister	138-1880	4
Strauss	1880-1900	46
Bainbridge	1900-1911	37
Clark (no detail given)	1880-1897	19
Dunoy and King	1912-92	14
Krauss	1903-192	26
Additional cases (Table II)	1920-1926	14
		03
	Duplicates	9
	Total	14

be entirely limited to the fetus but may also involve the membranes and the placenta or may be entirely limited to the latter structures. On the basis of the variations he proposed their division into three groups:

1. Lithokelyphos (stone sheath or egg shell) in which the membranes alone are calcified and form a hard shell surrounding the fetus. The fetus may undergo only slight change or it may be completely skeletonized but it is not involved in the process of calcification. Kuechenmeister believed this to be the most common type and the result of the membranes remaining intact around the fetus at the termination of pregnancy.

2. Lithokelyphopædion (stone sheath child) in which both the membranes and the fetus are calcified. The amniotic fluid has escaped or has been absorbed at the time of or soon after the termination of pregnancy and the fetus remains partially or completely surrounded by the membranes.

3. True lithopædion (stone child) in which the fetus is infiltrated with calcium salts and in which the calcification of the fetal membranes is negligible. This type he believed resulted when the fetus escaped unattached into the abdominal cavity, the membranes being either left behind or closely wrapped about the fetus.

While this classification has no clinical value it provides a convenient method of grouping specimens. The confusion resulting from the double use of the word lithopædion in referring to the general group as well as to the third group could be avoided by substituting the word lithotecnon when referring to the third group, the true lithopædion of

TABLE II—ADDITIONAL CASES REPORTED IN THE LITERATURE

Reported by	Age at death	Years carried	Age at death	Other specimens	
				P	Subsequent
A. I.	3	4	6	3	
A. Y.	65	3	9	?	?
B. I. I.	5	4	5	?	?
	49	4	5	(m. ca. ges)	
B. G.	54		9		
B. Q. H. Y.	3		9		
Legn.	?	4	9		
M. C. M. K.	73	5	9		
N.	4		6		
N. W. H.	55	?	?	8	
P. L. U. S.	5	?	?	7	
P. L. U. S. packm.	75	40	9		3
S. P.	67	6	5		
T. I.	46	6	?		

Age at death Years carried Age at death

Kuechenmeister in which the fetus alone is calcified.

In 115 cases reviewed in the literature some attempt has been made to group the specimens according to this classification. In 53 cases (46 per cent) they are described as true lithopædion or lithotecnon in 49 cases (46 per cent) as lithokelyphos and in 13 cases (11.4 per cent) as lithokelyphopædion. These figures at best are inaccurate because the cases have been described by a large number of observers and frequently the selection of the classification depends on the thoroughness of the examination of the specimen or on personal opinion.

MAIO CLINIC CASES

CASE 1. A woman aged 42 years presented herself at the clinic with obstruction of the œsophagus from extensive carcinoma. She had children aged 5 and 9 years respectively. Since the birth of the last child she had had what was thought to have been a miscarriage at about 3 months.

The patient died shortly after admission to the hospital. At necropsy the left ovary was found to be cystic and enlarged. In the fimbriated end of the left tube was a mass 4 by 3 by 3 centimeters which on section produced a grating sensation. This proved to be a fetus 6 centimeters long. Microscopically the soft tissues including the lungs contained scattered deposits of calcium salts. The specimen was classified as early lithotecnon or true lithopædion.

CASE 2. A woman aged 39 years had had 2 miscarriages the first at about the third month soon after marriage. Following one of these 19 years previously there had been slight bleeding from the vagina

for a month and during this time she had had several sinking spells and was ill for a week. She gradually recovered except for painful defecation which persisted for 5 years. She complained chiefly of bloating and leucorrhœa which had been present for 3 years.

The uterus was enlarged firm and irregular and a hard nodular mass moderately tender was attached posteriorly to the cervix and extended well up into the abdomen. The possibility of fibromyoma was considered and exploration advised. At operation multiple fibromyomata in the uterus and a calcified mass adherent to the right side of the pelvis were removed. Appendectomy was also performed. The patient had an uneventful convalescence but a postoperative hernia developed which was repaired 3 years later. A cyst of the left ovary with the corresponding tube which was chronically inflamed was also removed at this time. Six years after the operation there had been no subsequent pregnancies. Menstruation had been normal and general health good. There had been some leucorrhœa.

The specimen (Fig. 1) consisted of a calcified mass 5 by 3 by 3 centimeters in which several long bones the ilium and some cranial bones could be identified. There was no trace of the placenta or cord or other membrane. The specimen was classified lithotecton or true lithopædion.

CASE 3. The patient aged 44 had been married 22 years had had 5 children 3 living the youngest aged 9 years and 2 miscarriage at about 2 months. She complained of heartburn and abdominal discomfort which had started during the last pregnancy. Occasionally pain in the upper quadrant had been noted within the last 6 weeks.

Examination disclosed marked uterine prolapse and extensive old lacerations of the perineum. A small mass which was firm and tender occupied the posterior fornix. At exploration chronic cholecystitis with cholelithiasis was found and cholecystectomy was performed. An encapsulated mass adherent to the sigmoid adne and surrounding structures was removed from the left side of the pelvis. Appendectomy and a Kocher operation for prolapse were performed secondarily. Convalescence was uneventful. Thirteen years after the operation the patient's general health was good but she complained of severe vesical symptoms secondary to recurrent uterine prolapse.

The specimen (Fig. 2) consisted of a firm calcified mass about 4 centimeters in diameter composed of the fused and calcified remains of a fetus in which the cranial and some of the long bones could be identified. Nothing suggestive of the fetal membranes could be recognized. The specimen was classified as lithotecton or true lithopædion.

CASE 4. A woman aged 31 years who had been married 10 years had 1 child aged 5 years. Four years previously she had had a miscarriage. Since then she had felt weak and run down and had been aware of a sensation of weight in the pelvis. Menstruation ceased for 11 months following the miscarriage and then occurred regularly.

A hard rough tender mass posterior to the uterus was palpated. On bimanual examination crepitation could be elicited. A diagnosis of a dermoid or a calcified pelvic tumor was made and exploration advised. An infected lithopædion closely adherent to the right ovary the sigmoid and the small intestine was removed together with a hæmatosalpinx from the left side. Appendectomy was performed secondarily. The patient died on the eighth day from intestinal obstruction and diffuse peritonitis.

The specimen (Fig. 3) was 8 centimeters in diameter and consisted of a hard shell with walls from 0.8 to 1.0 centimeter thick representing the calcified fetal membranes. Within this shell was a completely skeletonized and partially disarticulated fetus together with some pus and necrotic material. The bones of the skeleton were unusually hard and brittle. Microscopic examination of the wall revealed fibrous tissue infiltrated with calcium salts. The specimen was classified as infected lithokelyphos.

CASE 5. A woman aged 25 years had been struck on the back by her husband 9 months previously when she was 3 months pregnant. Soon after this she became aware of a mass in the right lower quadrant and bleeding occurred regularly and profusely for a time. She was sick for about 7 months then menstruation recurred and the abdominal mass decreased in size. Subsequently there had been occasional bilious attacks and slight tenderness in the right side of the abdomen.

A hard mass was palpated in the region of the right tube. The uterus was in good position and normal in size. At exploration a large calcareous mass adherent to the small intestine was removed from the right side together with the corresponding tube and ovary and the appendix. Convalescence was uneventful.

The mass consisted of a fetus partially encapsulated by the remnant of the membrane and the placenta and cord attached (Fig. 4). The placenta was unusually firm and macroscopically showed areas of hyalinization and calcification. The fetus was fairly well preserved but it was dehydrated and shrunken. Microscopic sections of the cord showed numerous patent vascular channels many of which had thickened walls. The soft tissues of the body of the fetus were well preserved and were not calcified. The specimen was classified as early lithokelyphos.

CASE 6. A woman aged 52 years had 1 child aged 30 years. Sixteen years previously menstruation had ceased. The abdomen had enlarged. Secretion had appeared in the breasts and movement was noted in the abdomen. After 7 or 8 months she experienced slight pain in the left side and the abdomen gradually became nearly normal in size. Subsequently the patient regained health and menstruation was normal until 8 months before admission when it became irregular. There had been frequency of urination during the last 6 months.

The patient had not lost weight. There was a hard nodular mass in the pelvis a little to the left



FIG. 1. Case 2. Lithotecnion retained in the abdomen 9 year



FIG. 1. Case 3. Lithotecnion removed from the left side of the pelvis

of the uterus. Roentgenograms showed the outline of a fetal head in the left side of the pelvis with a dense oval shadow lying across the pelvis and extending up to the level of the fifth lumbar vertebra. Cystoscopic examination revealed diffuse cystitis. A pre operative diagnosis was made of lithopædion and a laparotomy was performed. The greater part of the fetus was found free in the peritoneal cavity but it was partially adherent to the sigmoid and omentum. The head was contained within the folds of the broad ligament on the left side. The mass was removed and the uterus which was adherent and retroverted was dissected free and fixed to the anterior abdominal wall. The gall bladder contained multiple small stones and was removed 17 days later. Convalescence terminated uneventfully. Four years after the operation the patient was enjoying excellent health and was working hard.

The specimen (Fig. 5) consisted of a partially skeletonized fetus with the cord and remnants of the placenta attached. The membranes partially surrounded the fetus and were closely attached to it at several points. Microscopically they showed hyalinization and calcification. The soft tissues of the fetus were shrunken, absent in places and there was gross and microscopic evidence of calcification. The specimen was classified as lithokelyphopædion.

CASE 7. A woman aged 26 years had 1 child aged 11 years. She had not had miscarriages. About 2 years before the examination menstruation had ceased and pain in the back and several fainting spells occurred. The abdomen increased in size but she was not aware of any movements as with the former pregnancy. At term she experienced labor pains and passed small pieces of tissue but no fetus. Subsequently the abdomen gradually decreased in size and menstruation reappeared but backache persisted.

A movable mass was palpated in the lower part of the abdomen. It appeared to be attached to the uterus. Roentgenograms revealed the outline of a

large fetal head and a long dense shadow lying transversely in the pelvis. Old extra uterine pregnancy and rupture were diagnosed. The fetus was removed at laparotomy. Convalescence was uneventful.

The specimen consisted of a degenerating fetus of about 8 months development with the cord and placenta attached. The latter was firm and on section produced a grating sensation. Microscopically there was extensive hyalinization and the tissues were infiltrated with calcium salts. The membranes were thickened and somewhat cartilaginous. They partially surrounded the fetus and were closely attached to it at several points. On microscopic examination the structures appeared to be fairly well preserved; there were deposits of calcium salts throughout especially marked within the vascular channels. The soft tissues of the fetus were firm and did not show gross or microscopic evidence of calcification. The specimen was classified as lithokelyphos.

CASE 8. A woman aged 4 years had missed 8 successive menstrual periods 4 years previously. She had been confined to bed during practically all of the first 4 months but her health improved and she was able to do housework during the latter 4 months. With the subsequent return of menstruation she gradually regained her health except for moderate dull pain and some soreness in the right lower quadrant. Five months before examination she again thought she was pregnant. There was severe pain in the lower part of the abdomen and she was confined to bed on several occasions. Subsequently menstruation reappeared, health was regained and all evidences of pregnancy gradually disappeared.

The cervix was small and the fundus of the uterus was moderately enlarged and retroverted. A mass about 10 centimeters in diameter was palpated in the left side of the pelvis and another about 3 or 4 centimeters in diameter was palpated in the right



Fig. 3. Case 4. Fetal lithokelyphoid mass.

side. Operation revealed bilateral ectopic uterine pregnancy. On the left side was a fetus 20 centimeters long and on the right side a lithopædion. Both fetuses were removed together with the ovaries, the left tube and the appendix and a plastic operation was performed on the right tube. The patient conceived naturally and a year later was well and doing all of her housework.

The specimens from the left side are a well preserved fetus that from the right side was a mass 15 by 9 by 6 centimeters (Fig. 6). The latter is closely adherent to an enlarged cystic ovary. The outer portion of the mass consisted of the membranes greatly thickened and in places almost cartilaginous. When sectioned they produced a grating sensation and microscopically they showed heavy deposits of calcium. Within this shell were the remains of an almost completely skeletonized fetus; the bones were unusually hard and brittle and the soft tissues were moderately infiltrated with calcium salts. The specimen was classified as a lithokelyphoid.

CASE 9. A woman aged 45 years had one child aged 3 years. She had had one miscarriage 14 years previously. Two years previously menstruation had ceased for 3 months followed by slight daily bleeding for months. Since then menstruation had occurred irregularly.

A firm mass was palpated to the right of the uterus. At exploration a fibromyoma of the uterus and a lithopædion from the right side of the pelvis were removed. Extensive inflammation surrounded the mass in the pelvis. The specimens as to be and not classified.

The classification of these 9 cases is as follows: lithokelyphoid 3 cases (37.5 per cent); lithokelyphoid 6 cases (25 per cent).

TABLE III—SUMMARY OF DATA IN MAYO CLINIC CASES

Age	Sex	Parity	Duration of pregnancy	Site of fetus	Site of lithopædion	Result
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.
15	F	1	8 months	4	6	rec. m. f. l.

lithopædion 3 cases (37.5 per cent) and unclassified 1 case.

The incidence of the different type in this series (Table III) corresponds roughly with that in the cases noted in the literature.

ETIOLOGY

The retention of a fetus within the abdomen its development to the third month or more, the absence of infection and the survival of the mother for a period of years are essentials for the production of a lithopædion. Lithopædion is invariably the result of extra uterine pregnancy. It is extremely doubtful if a fetus retained within a normal uterus ever undergoes this transformation because there the occurrence of infection leads rather to destruction of the tissue of the fetus and skeletonization. It is conceivable that a fetus retained within the rudimentary horn of an incompletely developed uterus might escape this fate and eventually undergo calcification because under the circumstances it would be protected to some extent from infection. But even so skeletonization usually occurs.

An analysis of the pregnancies responsible for the production of the fetuses of lithopædions shows that in 84 per cent of the Mayo Clinic cases and in 75 per cent of the cases reviewed there is clinical evidence of development to or beyond the seventh month and in 60 per cent to term. The average term of development in the series is nearly as could

be determined was about 7 months. It appears that only the more mature fetuses undergo this transformation.

Leopold has shown experimentally that an immature fetus free in the abdomen of a rabbit will rapidly undergo absorption. A similar fate awaits the immature fetus which enters the abdomen of a woman on the termination of extra uterine pregnancy.

It is impossible to obtain reliable data regarding the types of extra uterine pregnancy that are most likely to result in the production of lithopædion. In general it is the type in which the fetus is most likely to develop to near term and while this may occur in practically every type it is more common in some than in others.

In tubal pregnancy advanced development of the fetus within the tube has been observed but rarely. Pregnancy is usually terminated before the third month except in the rare instances in which secondary tubo ovarian, tubo abdominal, intraligamentary or abdominal implantation saves the fetus and permits it to develop to term. The same is true in the interstitial type of pregnancy. Primary abdominal and ovarian pregnancies are relatively rare but they reach advanced development oftener than do tubal pregnancies. Besides extra uterine pregnancy it is conceivable that a mature fetus might enter the abdomen as the result of rupture of a pregnant uterus and the mother recover without surgical interference. This accident however is usually fatal unless surgical measures are promptly instituted and then the fetus is removed from the abdomen.

The fetus that continues to develop to maturity will die from deficient nutrition unless delivered by abdominal section. If it remains in the abdomen it will be disposed of in some manner by the maternal organism.

Mummification, adipocere and various types of fatty change have been described in these retained mature fetuses but it is not known if these changes are entirely different processes or merely successive steps in the production of lithopædion.

The exact chemical process by which calcium is deposited in the tissues here or else where in the body is not well understood.



Fig. 4. Case 5. Early lithopædion retained in the abdomen 19 months.

MacCallum states that there seems to be something peculiar about tissues living or dead which gives them the power to catch up the calcium from the circulating fluid and hold it firmly in solid form. However no precise and satisfactory chemical explanation has been offered.

The diagnosis of lithopædion can practically always be made from the history but its presence is frequently not recognized because the condition is not borne in mind and the various events in the history are not correlated until the diagnosis has been made at operation. The symptoms may be divided chronologically into four groups corresponding to the successive stages in the development.

1. *The onset of the pregnancy.* In practically every instance the patient gives a history of pregnancy which has been atypical in some respects depending on the type of pregnancy responsible for the production of the fetus. The symptoms may be those of ruptured tubal gestation which continues as a second



Fig. 1. C. 1. tl. k. l. ph. pad. h. l. d. l. t. i. th. th. l. l. t. f. l. d. f. c.

any abdominal pregnancy. In such a case the symptoms attendant on the rupture subside but the abdomen continues to enlarge and the other evidences of pregnancy persist. In other case the symptoms may be mistaken for those of miscarriage but inquiry discloses the fact that a fetus was not passed and that instead of the usual sequence of event following miscarriage the abdomen continued to enlarge and the other evidences of pregnancy persisted.

In the event of primary abdominal or ovarian gestation the patient considers herself pregnant and may notice nothing abnormal during the early months except possibly pain or unusually active fetal movements.

2 *The termination of the pregnancy.* The latter months of the pregnancy are usually uneventful and at or near term labor is initiated in an apparently normal manner. The pains continue to be mild however and after from 24 to 48 hours they cease entirely without the delivery of a child. This constitutes what is commonly referred to as false or missed labor. The patient is not long deprived of fetal movements. She gradually recovers her health, menstruation returns and the abdomen decreases in size.

3 *Latent period.* The fetus now ceases to exit as such. It becomes a parasite in the maternal abdomen and while it may continue to derive some blood supply from the mother it leads only a passive existence. Its bulk has decreased with the escape or absorption of the amniotic fluid. Dehydration occurs and the tissues begin to be infiltrated by calcium salts. During this period the patient is free from symptoms except that she may still be aware of the presence of a mass in the pelvis. From two to six or more years may elapse in this manner while the fetus is being gradually transformed into a lithopædion.

4 *Late symptoms.* In about 6 per cent of cases if the patient lives late symptoms eventually develop. They consist of mild abdominal pain or consciousness of fullness in the pelvis frequently associated with a persistent foul vaginal discharge. Symptoms of bladder irritation may result from pressure of the mass on the bladder or from secondary cystitis. If the patient is untreated the lithopædion may rupture into the adjacent viscera or through the abdominal wall.

The general health of the patient may be unimpaired at this time or there may be considerable emaciation and loss of weight. A hard mass usually associated with slight tenderness is present in the lower part of the abdomen in practically every case. On vaginal examination this mass may be palpated on one or the other side of the pelvis. It is frequently attached to the uterus pushing it to one side. Its extreme hardness is characteristic and a crackling sensation sometimes may be elicited by pressure.

Koentgenogram are characteristic. Kirklin and Simon have pointed out that the fetus

appears much more distinctly than in a normal pregnancy because of its increased density and because it is not surrounded by amniotic fluid or the thick uterine walls. The fetus may also occupy an abnormal position and may assume an abnormal attitude or be completely disarticulated. Other tissues besides the skeleton which have become infiltrated with calcium salts will produce an extraskeletal shadow of varying density and outline depending on the extent of the calcification and the portions of the products of conception involved. Such observations in a patient who presents none of the symptoms of pregnancy or who has passed through the menopause or in whom a normal uterus can be outlined are sufficient evidence on which to base the diagnosis of lithopædion.

The conditions with which lithopædions are most frequently confused are calcified fibromyomata and ovarian dermoid. In the presence of a hard mass in the pelvis even when the history of a miscarriage or a somewhat atypical pregnancy is given either of these diagnoses may easily pass unquestioned unless the possibility of lithopædion is borne in mind. It should be remembered however that fibromyomata when they become sufficiently calcified to be confused with a lithopædion rarely produce symptoms and diagnosis should be made with caution when symptoms are present.

Ovarian dermoid may be a source of confusion except when they are bilateral. Previous miscarriage or atypical pregnancy is not an essential part of the history of ovarian dermoid although Kouchinsky found that in 63 per cent of the cases in his series there was a history of previous pregnancy or miscarriage. Roentgenograms of the pelvis always furnish positive data which establish the presence or absence of lithopædion or calcified fibromyoma and the presence of teeth will establish the diagnosis of dermoid.

TREATMENT

It appears from Kuechenmeier's article that the first case to be successfully treated by abdominal section was that reported by the barber surgeon von Weinhardt in 180. Since then the relative frequency of the surgically treated cases has steadily increased.



Fig. 6. Case 8. Lithopædion retained in abdomen 4 years.

The treatment is now practically always considered to be surgical unless the patient is advanced in years and free from symptoms or unless operation is contraindicated by some other reason. When the calcareous mass is more or less free in the abdominal cavity its removal is simple but when bound down to the neighboring organs by a dense mass of adhesion or if it has ruptured into some viscus and the whole mass is infected its removal immediately becomes more difficult and attended by some hazard. In instances where the uterus and adnexa are so closely adherent to the mass that it is necessary to remove them also. When the bladder or intestines are closely adherent to the mass frequently happens that partial perforation has already occurred and great care must be exercised in dissecting the organ free to guard against completion of the perforation or when this is unavoidable to recognize and repair it. The raw surface which remains frequently extensive and may be the cause of the formation of adhesion and intestinal obstruction.

PROGNOSIS

A lithopædion may not cause symptoms and its presence may be unsuspected until it is found at necropsy after the patient's death from some other cause. In more than 60 per cent of cases however symptoms attributable to the presence of the lithopædion develop after a period of quiescence of from 1 to 10 years. The symptoms are usually mild at first and may become more severe and attended by marked weakness and emaciation.

tion In neglected cases perforation into neighboring viscera or through the abdominal wall may occur

In Auvray's case carcinoma developed about the lithopædion the only case on record In the case reported by Bryant death was from intestinal obstruction

The mortality rate from the surgical removal of lithopædion is low In this series there was only one death the patient had an infected lithokelyphos The subsequent health of the patients was uniformly good over periods of 1 to 13 years after operation

The presence of a lithopædion in itself is not markedly inimical to conception or child bearing and may exert no influence on labor A number of cases have been reported in which conception and normal delivery have occurred in the presence of a lithopædion

SUMMARY

Lithopædion literally means a stone child but the name is applied to any fetus in which the soft tissues or the fetal membranes have become infiltrated with calcium salts One hundred and seventy four cases have been noted in the literature and 9 additional cases reported from the Mayo Clinic

Lithopædions may be divided into three groups depending on the structures involved in the process of calcification (1) lithokelyphos membranes alone calcified (2) lithokelyphopædion both membranes and fetus calcified and (3) lithotecnon (true lithopædion of Kuechenmeister) the fetus alone is calcified and the membranes are absent or closely wrapped about the fetus

The symptoms of lithopædion are always typical but the diagnosis is usually not made prior to operation or necropsy because the condition is not borne in mind and the significant events in the history are not properly correlated until after the diagnosis has been established at operation In the presence of a pelvic tumor which is unusually hard especially when attended by symptoms the possibility of a lithopædion should be considered Roentgenograms constitute a valuable aid to the diagnosis The treatment is usually surgical The mortality rate is low and the prognosis is good following removal

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CENTRAL DISLOCATION FRACTURES OF THE ACETABULUM

BA E L ELIASON A B M D Sc D F A C S PHILADELPHIA

AND

V W MURRAY WRIGHT M D PHILADELPHIA
F m th I D p a t m t f th U ty f P y l H j t l

SINCE 1778 when Henricus Allison (2) first reported a case of fracture of the acetabulum there have come to the authors attention fewer than 50 authentic cases of penetrating fracture of the acetabulum with central dislocation of the head of the femur. The condition has been described by different writers under various and cumbersome titles. Many of the cases were diagnosed only clinically and were unconfirmed by subsequent X ray operation or autopsy findings. Vaughan has covered the subject well. Reporting a case in a comprehensive review of the literature in 1911 he was able to find only 26 positive and 39 doubtful cases. Woerner (31) in 1907 collected all reported cases—41—but rejected 25 because the diagnosis was not substantiated. Since then Kellogg Speed has reported 1 case, Page and Bristow 1, Cotton 5, Rymer 1, Coley 1, Peet 1, Kleinberg 3, and Royal Whitman 3 personal cases and mentioned 5 others that came indirectly to his attention. Fuller's series is analyzed by Vaughan. Few writers have reported more than 3 personal cases. In

this article the senior author reports 5 personal and 10 other cases from the Surgical Service of the University of Pennsylvania Hospital.

The diagnosis is made essentially by X ray examination. A careful study of the reported cases enables the authors to confirm the two types described by various authorities and to point out that the two types are but relative stages (complete and incomplete) of a penetrating or bursting fracture of the acetabulum. Fractures of the acetabulum may be divided into three groups:

1. Fracture of the rim (Figs. 1 and 2).
2. Radiating fractures of the acetabulum including fractures of the floor and epiphyseal separation of the floor of the acetabulum (Fig. 3).
3. Penetrating fractures with or without intrapelvic displacement of the head of the femur (Figs. 4 and 5).

Cotton describes two types as smashing (radiating) and penetrating (or penetrating). The difference between the two from an etiologic standpoint is probably but a difference in the



Fig. 1. Case 8. Fracture of the rim with no displacement of the head at the time of the examination. The femoral head is on the table.



Fig. 2. Case 14. Fracture of the rim. Note that there is the first degree of displacement of the femoral head. Direct trauma.

of the femur into the pelvic cavity. The latter stage may vary from an impaction of the femoral head into the acetabular opening to complete dislocation with the head of the femur resting upon the sacrum.

ETIOLOGY

The early literature and inaccurately reported cases since then lead to the inference that the fracture and subsequent dislocation occur from violence to the acetabulum transmitted through the long axis of the femur by the neck and head of the femur. Falls from a height upon the feet probably may cause a fracture of this type but most cases that have been carefully studied (Moore, Whitman, Coley, Kleinberg) show that direct violence upon the great trochanter is the usual etiological factor. Vireaux claims to have produced experimentally fractures of the acetabulum by violence through the femur without adduction or abduction. Katz likens the production to the jamming of a hammer or axe handle through its own head by striking the head of the handle with great violence. Kroenlein has reported a bilateral case in which the patient had fallen and landed on his feet. Both femoral heads were found to be driven into the pelvis.

Though the diagnosis of penetrating fractures of the acetabulum and their degree is principally made by X-ray examination various presumptive signs may warrant one in making a diagnosis before roentgenologic examination is made. Attention is called to the fact that over half of the cases present fractures of other bones of the pelvis which may complicate or obscure the diagnosis. As Cotton points out when the acetabulum is smashed and the continued violence drives the femur against the pelvic frame after perforation of the femoral head the pelvic arch almost necessarily must give in (Fig. 5). Rivin has recently reported 5 pelvic fractures (Fig. 6).

SIMILE CASES

1. Flattening of the trochanter of the affected side will vary with the degree of central dislocation.

Shortening depends upon the extent to which the femoral head is displaced. Vaughan

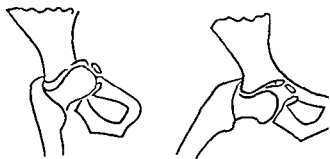


Fig. 7 Royal Whitman Abduction—Reduction. Note that the great trochanter acts as a fulcrum while the femur is abducted by drawing the head of the femur from the acetabulum.

noted in his 26 collected cases that outward rotation of the femur occurred in 11 cases and inward rotation in 1. Flattening of the trochanter in 50 per cent and shortening as a rule.

3. Flexion, abduction and external rotation likewise vary in amount or are absent; there is but relatively slight luxation.

4. Obturator pain depends upon fragment injury to or pressure of the femoral head upon the obturator nerve (Figs. 1 to 6).

5. Injuries to the blood vessels and bladder may occur with subsequent hemorrhage and extravasation of urine though these injuries are more common with accompanying fractures to the bone of the pelvis. Injury to the rectum is rare. Fuller's case (No.) presented blood in the feces and urine.

6. Crepitus may be present or not depending upon the degree of fracture and dislocation. Sands reports a case without crepitus, external rotation, eversion of foot or shortening.

7. Tenderness over and pain in the hip on lateral pressure over the trochanters is always present (Kleinberg).

8. Invariably there is a restriction with pain in all movements of the thigh though some cases have walked immediately after injury (Adams) and others have been unrecognized at the time. According to Fuller motion depends upon the size of the opening in the acetabulum. If the opening is small motion is greatly limited; if large the movements are free.

9. Palpation by rectum or vagina of the head of the dislocated femur and the displacement of fragments naturally depends upon the extent of pathology in the individual case. Of

cases collected by Vaughan the fracture or dislocation was felt by vagina or rectum in 14 cases

10 Occasionally pain and tenderness above Poupart's ligament is noted (Fuller) Neuhauf reports a 6 1/2 year old girl with a full Scarpa's triangle

11 Injury to the sciatic nerve with resultant pain and various degrees of paralysis may be noted

12 Since 50 per cent or more of the fractures are complicated by other pelvic fractures associated injuries may manifest themselves according to the individual case Ecchymosis over the great trochanter lower abdomen and scrotum may be present with or without tenderness and rigidity of the adjacent hypogastric region The junior author has noted in a recent case of multiple fractures of the left pelvis and ischium a marked swelling and ecchymosis of the corresponding left half of the scrotum occurring within 18 hours after injury due to trauma of the pudendal blood vessels of that side Fractures of any and all bones of the pelvis may occur as complications though those of the sacrum and coccyx are extremely rare (Scudder) Injuries to the os pubis and ischium are common (33 per cent and 20 per cent of this series) Sacroiliac fractures are probably frequently overlooked while the surgeon's attention is focused upon the primary lesion The authors cannot recommend too strongly the making of a careful and painstaking examination in co operation with neurologists when indicated of all fractures of the pelvis G G Davis has called especial attention to peroneal palsy (drop foot) which he says occurs in 10 per cent of all pelvic fractures and is due to trauma to the nerve at its origin in the lumbosacral cord as it lies at the pelvic brim

The nerve lesions most common to pelvic fractures are those of the peroneal obturator pudic and sciatic nerves Morrel Lavallee reports an autopsy in which the head of the femur was found pressing on the obturator nerve and explained the severe pain noted Adams reports a hyperesthesia of the lower sacral nerves disappearing in 48 hours in a case which was complicated by a sacroiliac luxation

NERVE COMPLICATIONS

In 15 of our cases nerve complications occurred in 5 or 33 per cent The sciatic was partially paralyzed in 2 cases or 13 per cent (Cases 1 and 15) Obturator pain occurred in 3 cases or 20 per cent (Cases 6 14 and 15) Peroneal paralysis occurred in 2 cases or 13 per cent (Cases 4 and 15) Pudic pain occurred in 1 case or 6.6 per cent (Case 1)

Injuries to the blood vessels viscera and bladder are most common in cases associated with multiple fractures of the pelvis These demand immediate surgical intervention Little appears in the literature relative to injury to the great blood vessels as the patients die quickly the bladder not infrequently (extraperitoneally or intraperitoneally) and the urethra may be crushed or lacerated in fractures of the pubis and ischium Acute retention of urine hæmaturia and extravasation of urine are to be watched for Extravasation will depend on whether the injury to the urethra occurs anteriorly between or posterior to the layers of the triangular ligament

In the first case the urine usually follows the rectum and reaches the margin of the anus In the second it dissects between the two layers where it remains until suppuration occurs or the surgeon's knife intervenes If rupture superficial to the anterior layer of the triangular ligament occurs the urine passes into the scrotum and may mount up to the abdomen between the symphysis and pubic spine Table I indicates the associated injuries found in the authors' cases

It would hardly seem possible that fractures of the acetabulum with or without central dislocation could escape unnoticed or be permitted to pass without an X ray examination Whitman however observed an opera-

TABLE I—ASSOCIATED INJURIES

	Cases	Per cent
Nerve injury	4	6
Fracture of femur		6
Fracture of iliopectoral groove	5	33
Multiple fractures of pelvis	8	53
Coccyx and fibula	3	6
Fracture of ischium		3
Albion's		6
Rupture of bladder	5	33
Hæmaturia		6
Psychosis		6
Scrotocele		6

tion for pelvic tumor which proved to be a previously dislocated femoral head a history and careful physical examination having apparently been dispensed with by the gynecologist. He also saw another patient who walked to the hospital with a cane and who still had pain 7 weeks after injury. Fuller saw a case 11 months after injury with ankylosis and atrophy of all muscles in a young conductor 27 years old who was practically a cripple and whose case had been diagnosed as contusion of the hip. Kleinberg has seen 3 neglected cases and decries the making and diagnosing of roentgenograms by practicing physicians who only incidentally and occasionally use an X-ray machine of their own. One patient came 4 weeks after injury with a cane and pain and the X-ray picture showed an acetabular fracture with little displacement of the head of the femur; the man refused treatment. A second had been kept in bed 6 weeks and then permitted to use a cane (with pain) before Kleinberg saw him. Examination revealed atrophy of the leg and the X-ray picture showed a fracture dislocation of the acetabulum with fracture of the os pubis. The third a female had been examined with the X-ray originally and the report was negative. She was kept in bed 5 months with baking and massage then (still with pain) was given a cane. She was seen 1 month later by Kleinberg (7 months after injury). Flexion and adduction were painful and abduction was markedly restricted. The X-ray examination showed a fracture dislocation of the acetabulum with a large intrapelvic bulging calcareous mass. Cotton has likewise seen a case of 33 years' duration though the man is quite active despite a stiff hip. Three of the present series were 1 to 30 months old before seen by the attending surgeon. Careful examination of the hip movements and measurements of the lower extremities cannot be overemphasized in all injuries to the pelvis and lower extremities.

SEX

Central dislocation fractures of the acetabulum occur more frequently in males than in females as more men are engaged in the industrial trades. Increasing rapid transpor-

tation and automobile accidents may affect either sex. In our service the sex incidence is 80 per cent males and 20 per cent females.

AGE

These fractures occur more frequently in early middle life. The youngest of our cases was 20 years old; the oldest 38 and the average 38 years old.

LOCATION

Kroenlein reports a case of bilateral fracture and one such case is included in the authors' series. The majority of cases apparently appear (11 to 3) on the left side.

INCIDENCE

Though the literature and textbooks would indicate that this condition is a relatively infrequent one, the authors find it not at all uncommon. Fifteen cases were seen at the University of Pennsylvania Hospital between 1909 and 1927 at the same time that 10,300 fractures were treated, making its occurrence assume the proportion of 1/687 fractures. During this same period 12 other fractures and epiphyseal separations of the pelvis were observed. As 4 of the reported series have occurred during the last 18 months and all were due to automobile accidents, it is thought that more fractures of this type may be seen in the future.

PRODUCTION

Of 8 cases in the literature in which the cause was mentioned, 7 were due to direct violence over the great trochanter and 1 was doubtful. Of this reported series 4 were due to jamming injuries to the hip in automobile accidents, 2 to direct force over the hip, 2 to crushing violence, 1 to a fall on the hip while skating and 6 were caused by falls from a height in which it could not be ascertained what part of the patient's body hit the ground first. Direct violence over the great trochanter was certain in this group in 9 of 15 cases or 60 per cent of the 7 of 8 cases from the literature 97.5 per cent.

TREATMENT

Delayed or non union has not occurred in either the authors' or reported cases. The

treatment varies in simple and complicated cases depending upon whether an acetabular fracture with central dislocation alone (46 per cent) or other fractures of the pelvis are likewise sustained (53 per cent). Grave injuries to intrapelvic blood vessel demand immediate operation and transfusion. Ruptures or lacerations of the bladder require immediate laparotomy, suture of the bladder drainage and a permanent catheter left in place until healing is assured. Laceration of the urethra requires perineal incision, repair of the urethra and the leaving of a catheter in place until healing has occurred.

When due to sacro iliac subluxation nerve injuries should be treated by immobilizing the sacro iliac joint when due to pressure of fragments or a dislocated femoral head they should be treated by reduction of the dislocation and an attempt should be made to correct or change the position of the fragments under anesthesia by flexion abduction or adduction and external rotation of the thigh under the fluoroscope. If the obturator nerve is injured by the femoral head or engulfed in scar tissue or callus formation little can be done other than the administration of palliative treatment. The sooner nerve injuries are recognized the sooner procedures and corrections can be instituted for their alleviation when they remain unrecognized until during or after convalescence little can be done. In peroneal nerve lesions the foot should be supported, massage and electricity should be applied early during fracture healing. One year later if there has been complete division or permanent damage to the peroneal nerve in the lumbosacral cord the peroneus longus may be transplanted into the anterior tibial tendon by the Mayer technique (Scudder).

Reduction of the dislocation is best done by closed methods. Either anesthesia and complete muscular relaxation should be utilized. Lateral (outward) rotation and longitudinal traction under anesthesia may be employed as advised by Cotton and others. Royal Whitman has had very good success in using extreme abduction and lateral traction during which procedure the great trochanter engages upon the acetabular rim or ilium and with the femoral shaft abducted as a long

lever the head of the femur is forced out of the pelvis (Fig 7). Kleinberg successfully used this method in a case of 7 months duration when lateral and horizontal traction or weight suspension would have been useless. Care should be used to cause no further damage than has already been done as sacro iliac subluxation and fractures of the pubis and ischium may injure nerves bladder and urethra if manipulated violently. If the dislocation is not reducible open operation is apparently unwise (Scudder). In a case (Vaughan) in which closed methods failed open operation resulted in suppuration of the hip joint.

Reduction may be maintained by the use of a plaster spica including the trunk, hips, thigh and leg the lower extremity being abducted and externally rotated. Page and Bristow advise 50 degrees abduction, 20 degrees flexion and 10 degrees external rotation so that the limb will be in the best functional position should partial or complete ankylosis take place. If the condition has been recognized early and treated no ankylosis has occurred in the authors series or in those cases reported in the literature. Partial ankylosis occurred in Kleinberg's case of 7 months standing but he nevertheless reduced it by Whitman's abduction method. Early motion will of course prevent ankylosis and should be instituted in all cases. In 5 or 6 weeks (Coley) the plaster spica may be cut at the knee the leg freed and mobilized and allowed to rest in a chair and walking permitted with crutches and later with a cane. The entire cast should be discarded 10 weeks after application if not sooner. Whitman had a recurrence when the spica was discarded after 7 weeks and the patient was permitted to walk. The dislocation was again reduced and immobilization for 10 weeks effected a cure. Length of immobilization in simple cases will depend upon the size of the perforation. Adams used a pelvic cast for only 10 days. Speed advises a plaster spica for approximately 4 weeks in the non penetrating type of acetabular fracture.

Loepp in a recurrent case used 20 pound extension for 3 months without splints or plaster. Scudder recommends suspension (in a pelvic cradle) and traction. The latter

should be considered in the presence of fractures to other pelvic bones. Fuller favors abduction or adduction traction and counter traction. Simple extension and immobilization with sandbags have likewise been used. As Cotton points out there is no standard treatment. Each case is and should be a law unto itself. Though abduction and weight extension may be sufficient in some cases considering the number of cases with associated fractures the plaster spica with the leg abducted, flexed and externally rotated is probably best.

RESULTS

In the literature the results have varied. In untreated cases in which there is not great penetration a new socket (with use of the joint) may form and give satisfactory function (Speed). There is generally some limitation of motion, slight shortening and stiffness of the hip (Scudder, Vaughan). Lendrick once saw a middle aged man untreated who later was able to take long tramping trips in German fashion. Autopsy after death from tuberculosis revealed the femoral head driven into the pelvis where a new bony cavity had been formed. Both pubes and ischium had been fractured. An unrecognized case in a young man seen by Fuller caused incapacitation for life. Coley's patient rode a bicycle 4 months after injury.

In the authors' series a follow up has been obtainable in only 7 cases, 46.6 per cent. Five of this number (Cases 5, 8, 11, 12 and 13) are doing their former work, one (Case 14) lighter work, and one (Case 15) is in an asylum with psychosis (due to fractured skull). Three have a slight limp (Cases 5, 8 and 11) and 3 (Cases 1, 13 and 14) show limitation of motion and slight pain (Fig. 6).

PROGNOSIS

Recurrence. Recurrence did not take place in any of the cases here reported. Speed advises resection of the head of the femur if the acetabular opening is large and recurrence continues. Whitman had one recurrence. Loepp, another, and Schloffer has shown by the X-ray a case that primarily showed only a fractured acetabulum but 5 days later when again subjected to X-ray examination there

was found to be a dislocation due to contraction of muscles. In simple cases the prognosis is good if reduction and immobilization are accomplished early. In complicated cases the outlook is grave. There is generally some limitation of motion with slight shortening and stiffness of joints depending upon severity of the fracture and associated injuries. Vaughan's 18 cases showed 3 perfect results, 7 with limited motion, 7 with shortening, with stiff joints, 1 with outward rotation and abduction, and 1 totally incapacitated.

Mortality. None of the 15 cases in this series died. Fuller reports 50 per cent mortality and Vaughan found 30 per cent mortality in 26 collected cases and 47 per cent in doubtful cases. The mortality is due to visceral injuries, complications and shock. 11 cases reported by Katz, 6 died in the first week. Arreger reporting 33 collected cases, fractures of the pelvis (diagnosis of central fracture dislocation proved in only 6 cases) showed a mortality of 16 cases, mostly in the first week.

In general it may be stated that simple acetabular fractures with central dislocation give a low mortality. Cases complicated by other pelvic fractures causing intrapelvic and intra-abdominal injuries and by cranial injuries are to be regarded as grave, their outcome depending upon early recognition and appropriate treatment.

SUMMARY OF FIFTEEN CASES AND REVIEW OF THE LITERATURE

1. Penetrating fracture of the acetabulum with central dislocation of the head of the femur is a distinct entity and not a rarity, is apparently on the increase because of the onward march of civilization.

2. There are varying degrees of this fracture dislocation.

3. Associated pelvic fractures occur in over 50 per cent of cases.

4. Pelvic and abdominal complications are ever to be borne in mind, anticipated and treated early.

5. Nerve injuries occur as high as 33 per cent. Careful examinations and due regard to patients' complaints are to be emphasized.

6 Unrecognized fracture dislocations occur too often

7 Reduction is generally best achieved by anaesthesia flexion and wide abduction with slight external rotation

8 Recurrence takes place if immobilization is not properly secured

9 Immobilization when possible should be secured by a plaster spica to the body hip and lower extremity placed in abduction slight flexion and external rotation

10 Mortality ranges from 0 to 50 per cent depending upon associated injuries complications and treatment

11 Careful and frequent examinations early treatment of all injuries and observant study will effect a shorter convalescence better anatomical result and increased function

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TRANSVERSE CONIOTOMY FOR THE RELIEF OF CERTAIN TYPES OF CASES OF LARYNGEAL OBSTRUCTION

By M. BACKER, M.D., BRIDGEPORT, CONNECTICUT

F m b D p t m t f s r y l l l b l f m d j h i c l f h n R R p t l

IN a certain number of cases laryngeal obstruction ends fatally either because immediate surgical attention is not available or because of untoward results following tracheotomy. Transverse coniotomy (incision of the cricothyroid ligament) offers an effective procedure in some of these instances. Its simplicity puts it within the hands of every practitioner in time of emergency.

HISTORY

The origin of relieving respiratory obstruction by the operative establishment of an artificial opening below the point of obstruction can be traced back to ancient medicine. A representative of the renaissance the anatomist Fabricius ab Aquapendente (1550) first devised the operation of low tracheotomy, which remained the only classical method until 1776. At that time another celebrated anatomist, Vicq d'Azyr (14), proposed before the Société Royale de Médecine a new operation based upon the division of the cricothyroid ligament (ligamentum conicum) and the insertion of a cannula for the relief of respiratory obstruction. Soon after this work was published a controversy arose as to the practicability of Vicq d'Azyr's operation. Among those who strongly recommended it were Furcroi, Bichat and Deault (7). A number of surgeons successfully performed the new laryngotomy on human beings but the operation was never generally accepted and soon disappeared.

Early in the nineteenth century Boyer originated the high tracheotomy. About the same time Deault (2) passed a curved tube along the nostril into the opening of the glottis and thus established the basis for O'Dwyer's work on the intubation of the larynx. In 1910 Otto Franck (5) urged the transverse division of the trachea. More recently Bingel (1) has ardently advocated this method and has pointed out its advantages. This operation however is a very

old one as it was introduced by Antyllus in the second century.

A vast amount of literature has accumulated on the surgery of the larynx and trachea. However only one author (1) as far as we know mentions that the incision of the cricothyroid ligament alone suffices to produce a satisfactory opening and does not need to be followed by the introduction of a tracheal cannula.

ANATOMY

The outstanding anatomical landmarks in this operation are the thyroid and the cricoid cartilages which are easily outlined on superficial palpation. Between the lower border of the thyroid and the upper border of the cricoid cartilage there extend the cricothyroid ligament. The anterior portion of this structure has a trigonal shape its side being formed by the cricothyroid muscles (Fig. 4).

The sternothyroid muscle diverge upward and do not lie in front of the conic ligament. The sternohyoid muscle lie laterally to the ligament however the latter is covered by a fringe of fascia connecting these muscle. Anterior to the ligament embedded in a small amount of connective tissue there are a few venules and lymphatic vessels penetrating the membrane. A small lymph node may also be found here the so called prelaryngeal lymph gland. Also a small anastomotic arterial branch crosses this field transversely connecting the superior thyroid artery which run laterally at a distance from the conic ligament. The course of this small artery is parallel and close to the lower border of the thyroid cartilage. This vessel can hardly be of any serious practical importance and it is not liable to be cut in a transverse incision of the conic ligament near the upper border of the cricoid cartilage.

In a certain number of individuals the lobes pyramidalis of the thyroid gland reaches the intercricothyroid space extending from the thyroid thus upward. It rarely consists

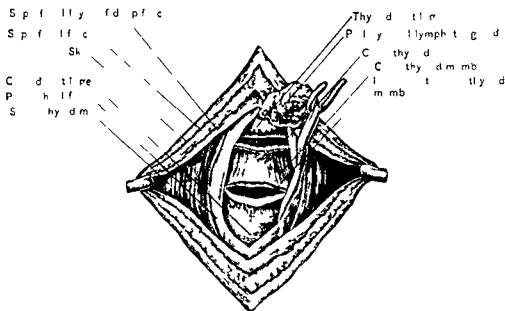


Fig. 1. Relations anteriorly of the cricothyroid membrane (From Deaver's *Surgical Anatomy*.)

of glandular elements but is essentially a small rudimentary structure made up of connective tissue and is of no significance whatever (12). The next layers anteriorly are the superficial fasciæ and lastly a more or less insignificant amount of subcutaneous tissue and skin. In some individuals the median vein of the neck may run subcutaneously in front of the conic ligament. Figure 1 is an illustration of the topographic anatomy of the operative field according to Deaver.

Posteriorly toward the laryngotracheal lumen the conic ligament is covered by a thin layer of connective tissue lying directly between the ligament and the mucous membrane of the larynx. This layer connects the ligament with the mucous membrane very firmly so that both adhere closely to each other. The entire thickness of these structures from the surface of the skin to that of the mucosa in many individuals does not exceed 8 millimeters.

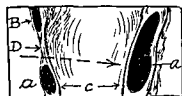
With regard to the topographic relation of the conic ligament to other nearby structures of the larynx the following has been ascertained by the examination of adult specimens.

A transverse incision of the conic ligament above the cricoid cartilage opens the upper respiratory tract at least 1 millimeter below the level of the true vocal cords. The lumen of the respiratory passage at the level of the

conic ligament is fairly round and has a diameter of about 15 millimeters. It is maintained and supported by the cricoid cartilage which is a strong complete ring and increases considerably in size from before backward. Indeed the posterior wall of the cricoid cartilage is about 2 centimeters high and about 3 millimeters thick. This is the only firm cartilaginous wall between the laryngotracheal tube and the œsophagus (Fig. 2).

As to the dimensions of the conic ligament itself its height is about 10 millimeters its length about 15 millimeters. It does not however end sharply but finds its continuation in the conus elasticus a structure extending along the walls of the lower division of the larynx (Fig. 3).

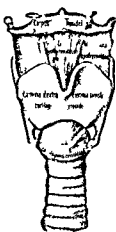
Histologically the conic ligament is a fairly firm elastic membrane whose fibers run parallel to the axis of the body from the cricoid upward to the thyroid cartilage. Consequently a transverse incision perpendicular to the traction force of the fibers of the membrane divides the latter into two parts which retract spontaneously. The resultant opening has a fairly regular oval shape with a long transverse and a short vertical axis and it remains open of its own accord. The divided mucosa closely adhering to the ligament through dense connective tissue follows precisely the spontaneously retracting parts of



Fig

I g S g t t l t t l
 n f th crn thv od m m
 b I C o d t l t
 o B thv d t l g p t
 C thv d a t l g e D m E
 c thv d m m l

F 3 R l t t t ly f
 th thy d m m l (Aft
 R b k p h)



F 3

the ligament. These phenomena were produced on fresh cadavers at autopsy.

EXPERIMENTS ON DOGS

The anatomical differences between transverse coniotomy in human beings and in dogs are slight. The distance from the vocal cords to the conic ligament in dogs is less than in the human subject. The sternohyoid muscles in dogs lie directly in front of the conic ligament, whereas in man the *c* muscles leave the ligament free between them.

Each animal was anesthetized by the administration of ether and fixed on the operating table with the head in extension. Then the administration of the anæsthetic was stopped and the dog's head, including the mouth and nostrils, was tightly bandaged with cotton towels and adhesive plaster. Thus breathing through mouth or nostrils was rendered impossible. A longitudinal incision was made in the midline from the incisura thyroidea down to the lower margin of the cricoid cartilage. The superficial fascia was split and retracted laterally to expose the sternohyoid muscles which were pulled aside as shown in Figure 4. The conic ligament was incised transversely and this incision was followed by immediate spontaneous retraction of the divided part, including the mucous membrane. In every instance the dog at once started breathing through the artificial opening. It was possible in all cases to perform the operation rapidly enough to relieve the animal from a *phryna*. No complications arose on the

operating table and ligatures were not necessary. The operative procedure was carried out with only one instrument—a calpel and was performed without assistance.

Before the dog was removed to the cage precaution was taken in order to maintain the coniotomy opening patent as the materials obstructing the mouth and nostrils were left in place and respiration could be carried on only through the artificial opening. Strips of adhesive plaster were fixed to the skin on either side of the incision wound and were united in back of the dog's neck. The sternohyoid muscles which in dogs lie directly in front of the cricothyroid membrane being sutured to the overlying skin were retracted with it. In front of the operative field a small thin layer of gauze was applied by means of collodion. As suture material silk was used.

A lapse of 4 hours was allowed between the operation and the removal of the material obstructing the dog's mouth and nostril. During that time the respiration remained undisturbed and the heart action was equally good. Following the removal of the obstructive materials in one group of dogs the artificial opening was kept patent for a period of 4 days. Then the skin edge was permitted to approximate and the wound was allowed to close. In another group of dogs the closure of the wound was facilitated immediately after the removal of the obstructive materials from the mouth and nostril. In some cases the edge of the skin as well as those of the divided fascia were united by a few interrupted sutures. In no case, however, was the wound closed completely.

Two dogs were killed and autopsy was carried out 4 hours after operation. When the interior of the laryngotracheal passage of these animals was exposed no blood was found in the lumen and the mucous membrane was pink and normal in appearance. The vocal cord showed no trace of any injury. The entire mucosa showed no change except at the cricothyroid interspace. Here an approximately oval shaped opening was seen with clean cut and sharply outlined edges. The mucous membrane adhered closely to the divided parts of the conic ligament (Fig 5).

In the dogs allowed to live the wounds became infected. However the infection remained localized and aside from the delayed healing of the wound was of no appreciable significance. Soon after the closure of their wounds (8 to 15 days after operation) the dogs started barking again and there was nothing suggestive of any laryngeal lesion. These dogs were allowed to live for a period of from 1 to 5 months and were further observed with regard to the possibility of undesirable after effects. In no instance was there any evidence of vocal disturbance or of any impairment of breathing.

At autopsy the following was found uniformly. The skin was movable over the operative field and the site of the longitudinal skin incision could be found only on very close examination. The larynx and trachea were removed from the body *en masse*. Externally these organs showed no deformity. The lumen of the larynx at the cricoid level was fairly round, the entire mucosa was smooth and pink in color and there was no loss of continuity in the lining of the mucous membrane. The cricothyroid interspace showed no appreciable changes on superficial inspection. The transverse incision through the conic ligament was not perceptible. Only on very careful examination could one make out in the submucous layer a round area about $\frac{3}{4}$ centimeter in diameter suggesting a radiating scar tissue formation with its center approximately in the middle of the cricothyroid interspace. The vocal cords were found intact and covered by a lining of normal looking mucous membrane.

REPORT OF CASE

I S. a white male 60 years of age complained of increasing hoarseness for months. The patient had a loud inspiratory stridor and his speech was only a hoarse whisper. Laryngoscopic examination revealed a hard immovable mass involving both the true and false cord on the left extending upward posteriorly and along the left wall of the larynx. This mass protruded above the left aryepiglottic fold and obstructed a very considerable part of the entrance to the larynx but was not ulcerated. The right vocal cord was movable, the left was fixed. The epiglottis was swollen and congested. There was nothing else of significance in the physical examination. The history was irrelevant except for the fact that the complaint dated back some 4 years prior to admission to the hospital.



Fig. 4. Transverse coniotomy, external view (dog).

The condition obviously was a carcinoma of the larynx. It was suggested by Dr. H. L. Swann, who knew of our work and to whom I am indebted for the privilege of reporting this case that a transverse coniotomy be performed on this patient instead of a preliminary tracheotomy.

The coniotomy was performed under local anesthesia with the patient's head in extension. The longitudinal incision of the skin was about 3 centimeters long and the transverse incision of the conic ligament was about $1\frac{1}{4}$ centimeters long. The patient remained well during the operation and started breathing through the coniotomy opening immediately after the conic ligament was split. All bleeding points were carefully ligated. The skin edges were caught by two stitches (silk) and the threads were tied to strips of gauze on either side of the wound. The two strips were tied on the side of the neck so as to retract the wound edges somewhat from the opening. On inspection of the respiratory passage through the coniotomy opening the mucosa was found to be of normal color. It was possible without any difficulty to inspect the lower surface of the vocal cord.

Soon after the operation it was observed that the patient was not breathing through the coniotomy opening as satisfactorily as he had on the operating table. On inspection of the wound a small flap of loose prelaryngeal tissue was seen attached near the coniotomy opening. This piece of loose tissue during inspiration was blown in toward the tracheal lumen, obstructing the opening in the conic ligament in a valve-like manner. Also the edges of the skin were not retracted from the coniotomy opening far enough to avoid its being covered by the skin when the patient moved his head to the side.

For this reason about 12 hours after the opera-



Fig. 5 Tracheotomy (d)

tion is performed a tracheal cannula is introduced through the cricotomy opening and is kept in the respiratory lumen for a period of 5 days. On the 15th day the cannula is removed. The skin around the opening in the cricoid ligament is then closed by the underlying tissues and the opening remains free regardless of the position in which the patient chooses to hold his head. For the following 2 days the patient remained perfectly comfortable without any cannula. As the stream of air passing through the opening tended to blow up the secretion from the respiratory passages in the lumen of the opening, it is a frequently necessary to remove from the dried up particles as well as the moisture. On the same day a complete laryngeal photograph of the patient's cricotomy opening in the eighth day after the preliminary cricotomy was performed. On the same day a complete laryngeal photograph was taken by Dr. Samuel C. Harvey. During the period in the hospital the patient received through a catheter introduced into the trachea through the cricotomy opening.

PROCEDURE IN MAN

In operating on man the skin edge should be retracted on either side and fastened to the underlying tissues by mattress suture entering the skin about centimeters away from the edge and passing through the anterior cricothyroid muscle of that side thus preventing obstruction of the cricotomy opening regardless of the position of the head and neck. Strip of adhesive plaster may replace this procedure if necessary. After a few days the suture may be removed and the adhesions allowed to maintain the desired position of the skin. Whatever is done after the cricotomy opening is no longer needed the wound should not be closed tightly and the cricoid ligament should not be sutured.

It is necessary to identify the cricothyroid interspace before the incision is made. The



Fig. 6 Tracheotomy (d)

skin incision should extend from the incisura thyroidae to the lower border of the cricoid cartilage. The cricoid ligament should be incised exactly transversely. The loose pre-laryngeal tissue must be removed and we found from experience in the reported case

ADVANTAGES AND DISADVANTAGES

A simple solution for the emergencies of laryngeal obstruction by the present method is not always possible. While O'Dwyer's intubation method is of great value chiefly in diphtheria in children it is not advantageous in other conditions. Both intubation and tracheotomy require special instruments and tracheotomy is a major operation which demands skill and some experience on the part of the operator. Even when performed under the best circumstances tracheotomy may give rise to serious complications such as hemorrhage. Following the teaching of Chevalier Jackson (5) most tracheotomies in this country are of the low type so that the serious complication of laryngeal stenosis is eliminated. Under certain circumstances however stenotic change may follow tracheotomy regardless of the anatomical level at which the operation was performed.

In comparison with the other method the operative procedure is simpler and the anatomical structures in

volved are of relatively little significance car- tilaginous substance is not cut and the lumen of the air passage is not altered the method reduces the possibility of hemorrhage and other complications to a minimum it opens up the largest of the interspaces between the laryngotracheal segments below the vocal cords it offers to every practitioner a simple and easy means of interference in emergency and it requires the use of only one instrument—a knife The postoperative development other things being equal is most favorable

It is interesting to note in connection with this operation that the chief arguments advanced against it for the past 150 years have always remained the same the proximity of the operative field to the vocal cords and the wearing of a cannula in the subglottic space Harmer (6) arguing in favor of this operation claims that a tube introduced through the cricothyroid membrane lies in the subglottic space well below the vocal cords and that healing of the wound takes place in from 5 to 20 days St Clair Thomson states (10)

Intercricothyrectomy is free from danger and easy to perform and the wound will heal in a few hours Both Harmer and St Clair Thomson find the method advantageous not only in sudden laryngeal obstruction but as a preliminary temporary measure in certain other operations

Since we feel justified in stating that on anatomical grounds as well as on the basis of our results on living subjects coniotomy does not require the use of a cannula at all it is needless for us to share the fear of a cannula in the subglottic space As to the possibility of directly injuring the vocal cords it may be said that such an injury cannot occur if the operation is performed with any care at all It is necessary to realize that indications for transverse coniotomy are limited It is obvious that only such respiratory obstructions come into consideration as are located above the level of the cricoid cartilage

The so called œdema of the glottis is the outstanding condition in which transverse coniotomy may save the patient's life It may occur at any age and may be associated with many conditions such as Ludwig's angina or any other inflammatory process in the vicinity

of the larynx burns or caustic irritation to the fauces foreign bodies in or injury to the larynx angioneurotic œdema some acute and chronic infections general anasarca Because of its frequent abrupt onset its rapidly progressive character and its tendency to give rise to no distressing symptoms at the onset these conditions often confront the practitioner when the patient is in real danger of suffocation In connection with œdema of the glottis it may be pointed out that this is a misnomer the condition manifests itself by a serous infiltration chiefly of the aryepiglottidean folds and not of the glottis It is an anatomically as well as clinically (11) well established fact that œdema of the larynx does not spread downward and never involves the subglottic space The site of this lesion is always at a higher level than the operative field of transverse coniotomy

Foreign bodies may lodge in the additus ad laryngem and produce a rather alarming situation For some reason or other it may be impossible at the time to remove the foreign body from the larynx and the physician may be urged to establish rapidly an artificial respiratory opening

Injuries to the larynx particularly cuts through the hyothyroid membrane and fractures of one or more of the cartilages may become very serious The resulting inflammatory reaction may cause severe œdema of the larynx or the lumen of the larynx may be occluded by either a dislocated fragment or a hematoma developing in the submucous connective tissue For this reason such patients are in constant danger For the sake of safety some authors emphasize the necessity of a prophylactic tracheotomy in cases of trauma of the larynx Provided the cricoid cartilage has not been fractured transverse coniotomy should be preferred invariably in such cases

For the establishment of a preliminary artificial respiratory opening transverse coniotomy approaches an ideal of safety If it is desired to administer a general anesthetic this can be accomplished either through a soft rubber catheter inserted through the coniotomy opening or else by saturating with the anesthetic a loose piece of gauze placed in front of the opening As an example of an indication of coniotomy as

a preliminary measure the operation for the removal of a carcinoma at the base of the tongue may be mentioned. Furthermore the possibility of inserting a radium needle through the coniotomy opening for direct application for subglottic tumors may be mentioned here.

CONTRAINDICATIONS

In *diphtheria* coniotomy should not be practiced because the obstruction of the air passages by the membrane may extend below the cricoid level. In *children* the distance between the cricoid and thyroid cartilage is too small and promise little success. We therefore believe that coniotomy should not be practiced in children.

SUMMARY

1. Many instances of laryngeal obstruction in the adult can be relieved by the transverse coniotomy of Vicq d'Azyr.

The introduction of a cannula is not a necessary step in the procedure because of the anatomical character of the cricothyroid membrane.

3. The procedure is simple and should be used in such emergencies as must be met with out the assistance of a surgeon.

4. It is not applicable in children because

of the small size of the membrane and not in obstruction which may lie below the thyroid cartilage as in diphtheria.

5. The operation is of particular value in the establishment of a temporary artificial airway in operations at the base of the tongue about the pharynx and buccal cavity.

6. This paper is based upon anatomical studies on the cadaver, experimental work on the dog and upon the application of the procedure in one case.

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MENSTRUAL FISTULÆ OF POSTOPERATIVE AND ENDOMETRIAL ORIGIN

By MAX BALLIN, M.D. I.A.C.S. DETROIT, MICHIGAN

MENSTRUAL FISTULA is proposed as a term for fistulæ in laparotomy scars characterized by periodic discharge of blood more or less coincident with normal menstruation. Two kinds of such fistulæ have to be considered (1) those due to direct communication with the uterine or tubal mucosa (2) those due to postoperative enclosures of endometrial tissue in abdominal scars.

ETIOLOGY

Most menstrual fistulæ are of postoperative origin though a few such fistulæ have been formed by a pus tube or a tubal pregnancy spontaneously breaking through the abdominal wall (cases of Bouzoul 4 Deverre 8 Schlink 35). Postoperative menstrual fistulæ are caused

1. By postoperative direct communication with uterine or tubal cavity (a) following cesarean section (b) after operations for pelvic inflammatory disease salpingectomy partial hysterectomy (c) after ventrofixation of the uterus.

By postoperative enclosure of endometrial (adenomyomatous) tissue in the abdominal wall in the course of hysterectomy ovariectomy ventrofixation etc. such enclosed tissue also at times causes a periodic menstrual discharge as we will show later on.

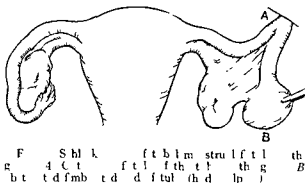
It is obvious that the menstrual discharge from a fistula going into the uterus is much greater than that from the type caused by endometrial enclosures in fact under certain mechanical conditions the whole or most of the menstrual flow may emanate through the fistula in the former type. The enclosures give only a slight but more or less periodic discharge.

Of fistulæ following cesarean section the following note were found in the literature.

Olshausen (7) mentioned in his lecture that the so called Porro operation was at times followed by menstruating fistula. The

old Porro operation meant supracervical hysterectomy immediately after a cesarean section with suturing of the cervical stump into the lower angle of the abdominal section. The aim of the procedure was prevention of peritonitis emanating from the uterus or after its removal from the infected cervical stump. As tubes and ovaries were usually not removed in the Porro operation the broad cervical stump menstruated the natural way through the vagina. If the cervical stump was attached to the abdominal wall an abdominal fistula often resulted communicating with the cervical canal and therefore participating in menstruation.

Holland (15) mentions the possibility and gives the origin of such fistulæ after cesarean section. Discussing defects in the classic cesarean operation he says: Every one knows how during the stage of closure of the wound the incision tends to gape transversely and the edges are drawn apart when the uterus contracts. If the contractions are very powerful small gaps which become occupied by blood clot inevitably occur between the suture. Many cases have been described in which it has been necessary to reopen the abdomen or which have come early into the postmortem room and the wound has been found widely open. If infection of the uterine wound occurs healing is delayed and an imperfect scar is formed. The liability of such thin scars to rupture in subsequent pregnancy or labor is very great. Even in case of mild infection the position of the incision makes adhesions between the uterine scar and omentum in testines or abdominal wall almost inevitable. Such adhesions if intestines are involved often lead to chronic or acute intestinal obstruction in the adherent intestine or breakdown of the linked intestine with formation of fecal abscess and fecal fistula. Then perforation of the thinned adherent uterine scar by erosion from the fecal fistula may lead to menstrual fistula. We will see later that



several men trul fistulæ were complicated by small fecal fistulæ

Loicq (25) in 1922 first wrote a compilation of cases of uteroparietal fistula following cesarean section and reports a case of his own

A woman aged 38 years after 6 previous pregnancies was terminated once by premature labor twice by pubiotomy and 3 times by forceps and delivered her tenth child in November 1921 through an ordinary high cesarean section. The uterus was closed by epiteutic suture of the muscular layer (silk) and of the peritoneum (catgut) the abdominal wall being uterine in 4 layers. The patient had fever for 10 days. Five to four hours after removal of the stitches on the eleventh day the abdominal scar gave away completely thus making necessary a new suture. The wound suppurated for several days and when the patient left the hospital 2 days later she still had a fistula at the lower extremity of the abdominal scar. *During the next*

stru l p i o d b l d f a d i o g h t u s t l a and in March a sound could be passed through it and into the vagina. In April the scar was excised by an elliptical incision. The uterus was adherent to the parietal peritoneum while the ovaries were polycystic and the tube thickened and adherent to Douglas's pouch. The operation was terminated by incomplete hysterectomy.

Loicq (26) found reports of 28 additional cases of uteroparietal fistula in the literature. The principal cause of this condition is infection. The fistula may be blind or complete. The diagnosis of the latter is easily made from the flow of menstrual blood through the parietal opening and by exploration with sounds or injection of colored fluid. Such fistulae do not necessarily prevent the normal development of subsequent pregnancy.

Loicq gives a method of prevention of such fistulae first by proper suture of the uterine wall and points out that the possibility of the fistula would also be greatly decreased

if a low cesarean section were always performed. Uteroparietal fistula may be treated by dilatation, injection or by modifying substance cauterization or by uterine suture. When the fistula is complete excision of the fistula and suture of the uterus may be contemplated or hysterectomy if it is feared that the tissue are so badly infected as to preclude the probability of thorough healing (Loicq).

Puccioni (27) reports a case of uteroparietal fistula following cesarean section. The first case was that of a 17-year-old woman. Operation had been performed for a supposed ovarian cyst but a 3 months pregnancy was found. For some reason a cesarean section was done. The abdominal wound did not heal and continued discharging for a period of 2 years. The patient then came to his clinic where the diagnosis of abdominal uterine fistula was made. In the fistulous region there was an extensive intestinal hernia. The second case was that of a 32-year-old woman who after 4 abortions and 2 pregnancies at term had the last of the terminated by cesarean section. In this case also a fistulous tract appeared in the abdominal scar soon after the cesarean section. This tract ordinarily drained pus but at the menstrual periods blood issued from it freely. Examination 2 years after the cesarean section showed the sigmoid colon perforated in its median portion. The perforated uterine fundus was in communication with the sigmoid and the exterior by fistulae.

The author also states that the causes of uteroparietal fistula following cesarean section must be looked for in faulty asepsis during the operation, secondary infection and faulty operative technique. The classic cesarean section particularly in the upper part of the uterus predispose to the formation of a uteroparietal fistula. As to treatment he states: While spontaneous recovery may be favored by the occurrence of a new pregnancy when the fistula is in the evolutionary stage there is grave danger of uterine rupture in the second pregnancy. The best treatment consists in the removal of the abdominal scar and the fistulous tract (including the origin of the tract) by means of cuneiform hysterectomy or subtotal hysterectomy according to the extent of the lesion. This operation must be followed

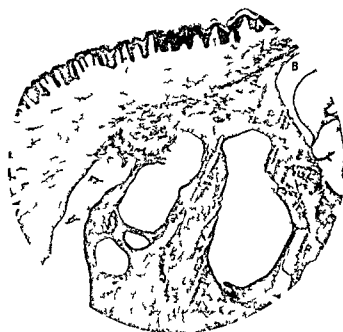


Fig 2 Endometrial enclosure in Case 3 A Epidermis of the abdominal wall B the cystic endometrial enclosure



Fig 3 From the same section as shown in Figure 2 high power

by perfect reconstruction of the abdominal wall

While the literature on menstrual fistulæ following casarean section embraces at least 32 cases including the 8 mentioned by Loicq communications of spontaneously formed fistulæ from inflammatory conditions and tubal gestations are more rarely mentioned Winkel mentions in his textbook under the head of vicariating (substituting) menstruation a case of Bouzol A progressed extra uterine pregnancy had become attached to and fistulous in the abdominal wall After discharging extra uterine fetal parts the fistula kept on discharging blood at intervals and also a slight amount of faecal matter (menstrual with complicating intestinal fistula)

Schlink (35) describes a tubal fistula originating from a pus tube in the groin discharging pus and at times blood

A small gland in the right groin was dissected out in a woman aged 30 years The wound did not heal thoroughly a small sinus discharging pus and at times blood persisted and for months resisted all efforts at closure The sinus was filled with bismuth paste and an X ray showed a sinus shadow leading in the direction of the internal abdominal ring about 2 or 3 centimeters in length and a large shadow in the midline of the pelvic cavity the paste evidently had made its way into the uterine cavity as it was

passed *per vaginam* in a very short time Upon laparotomy a condition such as shown in the diagram was found (Fig 1) The tubes were the seat of an old salpingitis The fimbriated ends were sealed and filled with clear liquid The right tube was kinked almost in harpin fashion and the bend was adherent to the anterior abdominal wall in the region of the abdominal ring Double salpingectomy cured the condition

Deverre (8) reports a menstrual fistula from a spontaneous rupture of a large perimetrio salpingitis through the navel

A woman aged 25 years since marriage in 1913 had suffered for 6 years from typical symptoms of pelvic inflammatory disease In 1918 there was marked abdominal distention intestinal disturbance and great emaciation Late in 1918 there appeared in the region of the umbilicus a little swelling which became progressively more marked the skin became thinned and red and finally ulcerated and discharged pus for several days then blood in greater or lesser amounts with intervals during which pus was discharged A cure was established by 2 operations First a large bottle shaped pus cavity was found in the right pelvic region the upper extremity of which reached to and communicated with the umbilicus The cavity was drained Suppuration continued At a second operation 3 months after the first a subtotal hysterectomy was performed In front of the old cutaneous fistula a second pus pocket was found and the appendix was entirely detached from the cæcum The patient recovered after a rather stormy convalescence

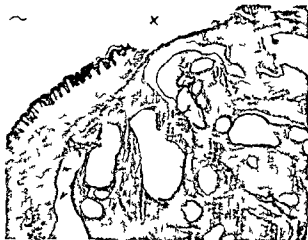


Fig. 1. The rupture of the pelvic floor, showing the fistula and the communication with the bladder.

The case of a pyosalpinx fistulizing into the bladder reported by J. Duvergey and Dreyer (10) suggests the possibility of menstrual blood being periodically discharged through the bladder as may also occur in the second type an endometrial enclosure in the bladder (Keene 16)

A woman aged 34 years was admitted complaining of general exhaustion and intractable cystitis. Urotropin infusions and local therapy with silver had been employed without effect. The urine was loaded with granular material at times bloody. Vaginal examination showed that the uterus and adnexa were immobilized in an inflammatory mass filling the pelvis. Especially a large tumor of the right tube could be palpated which adhered to the wall of the bladder. Catheterization of the left ureter was easy but it was impossible to catheterize the right. Radiography after the intravenous injection of 5 cubic centimeter of sodium bismuthate showed the shadow of the right tube communicating with the bladder. Following a course of intravenous therapy for about 6 weeks the fistula closed and the adnexal mass disappeared and the cure was eventually complete. Ordinarily abdominal hysterectomy is indicated in case of albugineous fistula but the poor general condition of this patient contraindicated surgical intervention.

Our cases of direct menstrual fistula followed operations for salpingitis and ventrofixation.

CASE I. Mrs. L. F. aged 36 years admitted to Harper Hospital October 5, 1922, stated that she had been married 16 years but had no children. In 1917 on account of stilted backache and dysmenorrhea she was operated upon for salpingitis.

She was reoperated on account of one month later adhesions were separate and one ovary was excised. Following this operation there was as much pain radiating into the legs as the fistula in the laparotomy scar continuously discharging serous material some intestinal gas and particles of thin stool. At times the discharge came topped up and then a swelling appeared as painful until it broke and discharged red homogeneous strual like blood. The vaginal menses were scanty. The patient was in every general condition. Diagnosis: intestinal and strual fistula following operation for retroversion. She was operated upon again by us on October 19, 1922.

The fistula was packed with iodoform gauze. Through an elliptical incision surrounding the fistula scar of the former laparotomy the whole of the fistula was dissected from the abdominal cavity. The fistula millimeter in diameter communicated with the lumen. Other diffuse intestinal adhesions were present. The intestinal fistula closed by internal anastomosis. The patient remained in the hospital for 10 days. Details on account of inseparable adhesions not be made out. The patient was not cured. She lost weight. Menstrual discharge slight amount of gas and stool at times menstrual blood. Fully recovered health a good further attempt to locate the fistula on the meninges perhaps to be made. The patient was discharged on October 19, 1922.

CASE II. Mr. T. B. 55 years old first married 1903 stated that he had been operated upon for pelvic inflammation twice. She stated that after the operation the pelvic infection did not clear up. The patient was in the hospital for 10 days. The patient was discharged on October 19, 1922.

Operation June 5, 1923. The patient was operated upon for pelvic inflammation. The patient was discharged on October 19, 1922.



Fig. 5 Case 3 Mrs. M. Postoperative menstrual fistula. Direct communication of the fistula through the endometrial enclosure into the uterine cavity. Also note the intestinal adhesions to the enclosure.



Fig. 6 Case 5 Miss I. Menstruating postoperative fistula with abdominal wall enclosure. Note the cystic areas penetrating the wall and attached to the cystic right ovary. Also note the intestinal and omental adhesions.

left-sided tubo-ovarian abscess was opened which contained about 50 cubic centimeters of pus without odor. The left tubo-ovarian sac was freed and resected. The intestinal loop was so much damaged and so fistulous in several places that resection was performed. This patient died from peritonitis 15 days after operation.

There are over 40 cases of this type reported in the literature so far for which the use of the term *menstrual fistula* is justified because of the direct communication of the uterine cavity with the abdominal fistula. Their origin from the perforation into the uterine cavity after cesarean section and from deep sutures into the uterus introduced for ventrofixation is easily understood. As the tubal mucosa either takes part in menstruation or communicates with the endometrium it is also obvious that tubal fistulae from salpingectomies or from spontaneous rupture of tubal abscesses and tubal pregnancies through the abdominal wall may also emit menstrual blood.

Our next cases of menstrual fistula are of a different and very interesting type due to postoperative enclosures of endometrial tissue in the laparotomy scars. In 1896 von Recklinghausen (41) perhaps gave the first lucid

description of this type of tumor starting from the uterine glandular and muscular tissue under the heading of adenomyoma and cystadenoma. He considered that these tumors started from enclosures of remnants of the Wolffian ducts. The next important publication is by Cullen (17) who considered the origin of this type of tumors as endometrial cells invading the muscular layers from an adenomyoma of the uterus. A third theory of their origin is mainly defended in recent years by Sampson (30, 31, 33) in his many publications. He claims that this type of tumor originates from endometrial cells escaping through the tube during menstruation and implanting themselves usually in the ovary but also in the peritoneum and the intestinal serosa. The latter theory has perhaps found the most followers but cannot explain the origin of all these tumors. Therefore several authors maintain that these tumors have different causes that some are caused by transplantation and enclosure of endometrial cells or the tumor starts from an embryological enclosure (Davis and Cron 6 and others).

Because of the different views as to etiology these tumors which really belong in one

of endometrial tumors in laparotomy scars, Nicholson compiled in 19 6 15 followed ventrofixation 6 operations on the tubes and ovaries 1 or 2 each for ruptured uterus hysterectomy and round ligament operation showing the frequency of these enclosures after ventrofixation

As to the dispute briefly referred to about the origin of these tumors Sampson's theory is that the endometriosis is due to the escape of menstrual blood through the tubes into the peritoneum and the consequent local reaction produced by endometrial cells carried along with the menstrual blood. In favor of this theory are the following observations

Jacobson (14) and Dossena (9) produced endometrial implants experimentally in the peritoneum of animals by scattering endometrial cells into the abdominal cavity. The question as to whether menstrual blood issues from the tube during menstruation has been disputed but Curtis operated purposely during menstruation and saw in 3 cases menstrual blood coming from the tube. Danforth saw the same on at least 1 occasion. Curtis asserts that 16 cases of endometrial implants all had retrodisplacements of the uterus favoring the back flow of menstrual blood and all had patent tubes. Chocolate cysts occur only in patients with patent tubes (Danforth offers this in favor of the implantation theory) also the most pronounced complaint of such patients is *painful* menstrual periods. Schwartz mentions the fact that the ovary is the favorite organ for implantation of endometrial transplants because it is the nearest organ to the tubal orifice. Davis and Cron (6) observed that in one case the implantation of endometrial cells followed transuterine inflation.

On the other hand Novak operated on 13 women during menstruation without seeing any menstrual blood coming from the tubes. He found endometrial cells only in 7 tubes of the several hundred examined and these cells had not the characteristics of menstrual endometrial cells. Nicholson does not accept the theory of endometrial transplantations or the origin of embryonic enclosures of this type of tumors. He believes that they are caused by proliferation of the peritoneal epithelium in response to some irritation.

Most likely there are several origins of such tumors. It is reasonable to claim implantation of endometrial cells in the many cases now reported in which endometrial enclosures occur along the tract of ventrofixating sutures in the abdominal wall or where a cystic ovary connects directly with an endometrial tumor in the scar. Endometrial enclosures in the vaginorectal septum seem to be more of an embryonic enclosure type starting from Wolff's or Muller's ducts. The outcome of the dispute will probably be that tumors in different locations have different origins. Mount (24) gives 5 varieties of endometriosis

1 Primary endometriosis direct invasion of myometrium by endometrial cells adenomyoma of uterus and tubes

Peritoneal or implantation endometriosis endometrial cells invade the peritoneal surfaces

3 Transplantation endometriosis in abdominal scars

4 Metastatic endometriosis extraperitoneal along the round ligament and in hernia sacs (comparable to metastasis from carcinoma)

5 Developmental misplaced endometrial tissue

The menstrual discharge from endometrial enclosures in scars of the abdominal wall is not so readily explained as the menstruation from direct fistula. At times (Fig 5) the endometrial enclosure still communicates with the uterine cavity at the place of ventrofixation or with a cystic ovary (Fig 6). Here again the menstrual discharge through the fistula is understood. In our third case of this type and most other cases in the literature such connection between fistula wall enclosure and uterine cavity or ovary was not found. Hence we must come to the conclusion that endometrial enclosures in a laparotomy scar and elsewhere are apt to secrete and discharge blood at intervals. This indeed is true and borne out by actual records of cases and the anatomy of the enclosures.

Menstruation or menstrual symptoms from these tumors are mentioned frequently in the literature. Some of Cullen's cases gave a history of enlargement of the umbilical adenomyoma at the time of menstruation and one of his patients noticed a serous discharge dur-

ing catamenia Mahle and MacCarty describe an adenoma of the umbilicus a hard bluish tumor that broke open and discharged bloody serous fluid This tumor became quite painful at the time of menstruation Nicholson mentions that menstruation was often marked by increase in the size of the tumor and pain and in 3 cases was accompanied by a bloody discharge from the surface of the tumor Mahle and Carpenter give 2 cases of abdominal scar enclosure and state that the lump was painful at the time of menstruation also the two inguinal case had the same complaint and so did the one with the adenomyoma in the rectovaginal septum One of them had a polypoid tumor formation raising the vaginal mucosa The occasional relation to menstruation of pain and swelling of the tumor or less frequently a bloody discharge should be very suggestive of adenomyoma Nicholson calls these tumors accessory uteri in build as well as function Heaney (11) states that usually the nodules swell and are painful during the menstrual period and afterward for several days Lochrane (19) under the heading of Endometrial Adenomas describes a postoperative cyst in the abdominal wall that discharged blood Sampson (31 33 30) also states that endometrial implants react to menstruation pregnancy and menopause as does the mucosa lining the uterine cavity F E Keene's case of endometrial invasion of the bladder healed after bilateral ovariectomy In criticizing this report Polak adds that endometrial tumors atrophy when ovarin stimulus ceases Even an endometrioma of the sigmoid caused dysmenorrhoea (Sharple 36) Heaney (11) mentions in reference to the endometrial tumors in the rectovaginal septum that of this type of tumor became fistulous in the vaginal vault producing polypoid like formations One of ours did this also

From our own observation and from the data in the literature it is evident that pain as well as bloody discharge are outstanding symptoms of endometrial tumors

Our 5 cases of endometriosis 3 in abdominal scars 2 in the rectovaginal septum had menstrual or near menstrual symptoms from their endometrial tumors These cases follow

CASE 3 Mrs G M 27 years old admitted to Harper Hospital February 1924 Complaint periodic discharge of blood from a fistula in the abdominal scar She had been operated upon 6 years previous removal of left tube and ovary through a median laparotomy A fistula followed the operation and discharged some what all the time and became more painful with increased discharge at the time of the menstrual period Several times the fistula had to be reopened to evacuate painful menstrual retention The diagnosis was a menstrual fistula

An elliptical incision surrounding the fistula and a scar was made In the wall was found a typical endometrial enclosure with bloody spaces The fistulous tract led to the adherent fundus uteri Several intestinal adhesions were present and adherent to the fistulous tract The fistulous tract was excised from the uterus The small wound of the uterus was sutured The abdomen was closed tight with special attention to the fascia to avoid future formation of hernia

CASE 4 Mr A S age 35 was first seen on July 1906 She had had one miscarriage at the age of 4 months She was operated on when 31 years old in a Toledo hospital A uterine tumor right tube and ovary were removed The tumor was diagnosed In the scar of this operation a tumor developed a degree slowly in size The tumor was tender and very painful during menstruation She said It feels as though it would burst At such times some dark bloody discharge stained her underwear over the tumor Profuse menstruation occurred every 3 weeks

The other wise healthy appearing woman had a long median laparotomy scar In the lower half there was a round raised dark colored firm tender mass cystic in place sometimes in lamellar adherent to skin and to fascia and muscles In this center a small cystic area moist on its surface in some brownish discharge

Vaginal examination showed the uterus large and adherent to the scar in the region of the tumor A diagnosis of abdominal wall enclosure of the menstrual fistula was made

At operation October 8 1906 an elliptical excision of the laparotomy scar including a cystic like tumor inches in diameter was made The tumor was removed and penetrated the whole and connecting with an ommental string going to the fundus of the uterus Very diffuse ommental adhesions covered up the whole pelvis After they were separated a fistulized fibroid uterus developed The fibroids were posterior closest to the cervix The right adnexa had been removed at previous operation The left hysterosalpinx the cystic ovary was found Supracervical hysterectomy was performed with removal of left adnexa a small ovarian tumor being left in place and toilet of the ommental adhesions were carried out The pathological findings of the tumor removed as a ten years old of the abdominal wall The patient was cured

CASE 5 Miss V I 22 years old was seen in May 1927. A left oophorectomy had been performed 6 years previously for a pelvic inflammatory condition. In the lower angle of the laparotomy scar there was a hard irregular enclosure that had required lancing during the past year or broke to discharge some blood. The tumor was always painful during menstruation and the pain was relieved by opening one of the blood cysts that formed. This patient was operated upon for menstrual fistula on May 5 1927 (Figs 6 and 7).

The whole endometrial mass was dissected loose. It penetrated diffusely into the right rectus muscle and communicated with an adherent cystic right ovary. The appendix also was involved in the adhesions. Excision of the whole mass and resection of the cystic ovaries led to a complete cure.

A history of our 2 cases of rectovaginal enclosures follow.

CASE 6 A Miss H M a nurse who complained of pressure on the rectum and pain which was so much worse during menstrual periods that she had to take anodynes. A small tumor formation in the posterior vaginal vault could be felt. On laparotomy a fibromatous tumor was found in the rectovaginal septum containing bluish cysts. It looked like a rudimentary duplication of the uterus. The tumor was then also exposed through the vagina and some chocolate fluid was removed from a hemorrhagic cyst. Complete excision of the mass was not done on account of the intimate relation to the rectal wall. Following this operation dark fluid was discharged from the vaginal cysts and these became very painful during menstruation. The pain was relieved sometimes by puncturing the small cysts in the vaginal septum.

CASE 7 Mrs C G 35 years old was referred for a tumor similar to that in Case 6 palpable in the rectovaginal septum and very painful during menstruation. We thought we had to deal with a tubo-ovarian cyst but at operation we found the same type of nodular mass with cystic enclosures—an endometriosis of the rectovaginal septum.

The literature and our cases mentioned show that tumors occurring in laparotomy scars may be identical with endometrial tumors which are found elsewhere on the surface of the peritoneum in the rectovaginal septum sigmoid etc. These tumors have arisen from to 25 years after laparotomies (Nicholson). They always seem to be restricted to the lower half of the abdominal wall. It has been established that these tumors of the wall are identical in structure and cyclic function with those of the uterine mucosa (Lemon and Mahle). Moreover it is very probable that in

some cases there has been direct transplantation of uterine endothelial cells by means of the needle and suture in ventrofixation. It is also significant that menstrual fistulae are frequently complicated by fecal fistulae. fistulae after cesarean section usually followed unsatisfactory suture of the uterus.

Faecal fistulae were present in addition to the menstrual in Puccioni's second case and in Bouzoul's case. In Deverre's case a gangrenous appendix was involved in the adhesions around the fistula. Of our patients Case 1 and Case 2 had intestinal fistulae with the menstruating fistula. Intestinal adhesions without fistula are mentioned in Puccioni's first case and were present in Cases 3 4 and 5 of our series. All of ours had postoperative hernias in the scars around the fistula just as mentioned in Puccioni's first case.

All these facts show that a certain prophylaxis against menstrual fistula is possible and coincides usually with modern surgical rules for pelvic operations. Cesarean section should be done in the low subperitoneal part of the uterus. The peritoneal (bladder) flap covering the uterine suture and low location of this scar will prevent its adhesion to the wound in the abdominal wall. Such adhesion is favorable to the formation of a uterine fistula. If a high cesarean section cannot be avoided proper suturing of the uterus will prevent to some extent the formation of such fistulae. In dealing with tubal and uterine stumps good peritonealization and oversuturing of raw surfaces will prevent adhesions between wall and uterus or tubes.

Ventrofixation in the presence of pelvic peritonitis seems to be especially prone to be followed by menstrual fistula. If the fixating suture penetrates into the uterine cavity and fixates the fundus to the laparotomy an excellent chance for menstrual fistula is created. Intestinal adhesions to ventrofixations with linking breaking down of the linked loop and formation of a faecal fistula will create septic conditions around the ventrofixating sutures again easily leading to uterine perforation and fistula. Ventrofixation by deep sutures through the fundus in inflammatory conditions is best avoided and in any case generally has not much in its favor.

Wall enclosures are created when raw uterine tubal and ovarian surfaces come in contact with the abdominal wound. The covering of such raw surfaces, uterine stumps, etc., will prevent formation of abdominal wall enclosures and thereby the production of menstrual fistula. Peal implantation of detached uterine or ovarian tissue in the scar is rare and is obviously avoidable.

In operating for these fistulae the presence of a fecal fistula or the injury to densely adherent intestines renders the prognosis of such operations somewhat more serious than one would think. Death in Case was from peritonitis following the operation, no doubt due to infection from the fecal fistula. At a certain clinic in view of several unsuccessful attempts to close the fistula further operations were declined, no doubt wisely, as the outcome of our operation indicates. However, the discomfort of this patient from the still complicating tubal abscess demanded interference. Because of difficult adhesions or the presence of a fecal fistula the operation is serious. Then too if the adhesions prevent exposure and resection of the fistulous uterus or tube the fistula is likely to recur (Case 1).

Radical operation for a fistula should mean total excision of the fistulous tract or endometrial scar enclosure in continuity with the uterine fistula or ovarian cysts by hysterectomy, total or partial ovariectomy as the case may be.

CONCLUSIONS

1. Menstrual fistulae are fistulae in the abdominal wall characterized by a periodic discharge of menstrual blood.

They rarely originate from spontaneous rupture of a pus tube or an extra uterine pregnancy through the abdominal wall. Usually they follow operations, caesarean sections, ventrosixations and salpingo ovariectomies and then either connect directly with the lumen of a tube or the uterine cavity or connect with menstruating endometrial enclosures in the laparotomy scar.

2. Frequent complications with extensive intestinal adhesions and fecal fistulae occur and render the operation for them somewhat difficult.

3. The name menstrual fistula and perhaps also menstrual tumor for postoperative and endometrial enclosures is proposed to emphasize their outstanding symptoms just as fecal and urinary fistulae describe an entity.

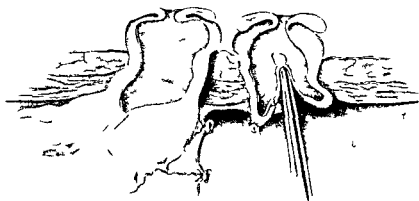
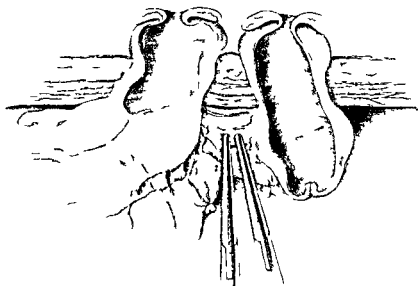
4. Menstrual fistulae and the endometrial tumors are painful and discharge more or less blood at the time of menstruation.

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The Technique of the Interior Resection of the Rectosigmoid—Fred W. Raab

CLINICAL SURGERY

FROM THE DIVISION OF SURGERY MAYO CLINIC

THE TECHNIQUE OF ANTERIOR RESECTION OF THE RECTOSIGMOID¹

By FRED W. RANKIN, M.D., F.A.C.S., ROCHESTER, MINNESOTA

RECTOSIGMOID is an anatomical name for a portion of the gastro intestinal tract which strictly speaking represents the continuation of the pelvic colon above into the rectum below but which surgically speaking represents a division of the large bowel which includes not only the last 5 centimeters of the sigmoid but the upper 5 centimeters of the rectum proper. It is the smallest part of the large intestine and possesses a mechanism whereby the fecal current is retarded or stopped so that normally the rectum is practically always empty. The rectum proper begins at the third sacral vertebra and extends to the top of the prostate in the male and to the perineal body in the female landmarks which correspond with the beginning of the anal canal. At the point at which the sigmoid enters the top of the rectum from the left side the direction usually changes thus making an angulation as the peritoneum covered colon merges into the retroperitoneal portion of the pelvis. The narrowing of the bowel at this point is not the only anatomical peculiarity of the anastomosis there is a distinct difference in the mucous membrane of the two divisions of the large bowel that of the sigmoid being thrown into rugae and appearing as distinct from the rectal mucosa as the gastric mucosa is distinct from the duodenal mucosa at the pylorus. This change in the appearance of the mucous membrane is characterized by an increased blood supply and a greater freedom of this internal coat of the bowel. There is no change in epithelium at this point in the gastro intestinal tract such as is noted lower in the anal canal which is lined with pavement epithelium and has no mucous glands (Fig. 1).

It has not been definitely proved despite frequent assertions particularly in discussing the etiology of such vague diseases as megacolon that there is a definite sphincteric mechanism at the rectosigmoid. Unquestionably there is a distinct narrowing of this portion of the intestinal tube. Peaves in 1917 dissected out the rectum

and rectosigmoid in 46 cadavers and found that a terminal constriction was present in 86 per cent and that in two instances the narrowing was so definite as to reduce considerably the caliber of this portion of the bowel. More recently Martin and Burden in discussing the sphincteric action of the rectosigmoid observed that of 31 specimens examined 12 showed a distinct and abrupt transition in the appearance of the mucous membrane between the rectum and sigmoid in the others the transition was more gradual at varying distances up to 31 centimeters from the anus. Regarding the musculature at this particular point however they assert. As a rule the sigmoid has a well developed musculature exhibiting no local increment of circular fibers to suggest an anatomical sphincter nor is there a constant perceptible narrowing at the rectosigmoid junction. Anatomically this is a favorite site for neoplasms and its inaccessibility is proverbial among surgeons. Too high to be attacked readily by a posterior type of operation it is at the same time too low to be easily accessible by the abdominal route except in cases in which the anatomical conformation renders the difficulties less marked.

The acceptance of the postulate that all carcinomata that are extirpable should be dealt with radically not alone by their removal but by removal of the contiguous gland bearing tissues as well predicates a formidable procedure in dealing with malignancy in this situation. The lymphatic drainage involved in carcinomata of the rectum that are above the anal canal has been excellently worked out by Miles who divides the lymphatics which drain the rectum into intramural and extramural groups. The intramural group is found in the rectal wall one plexus is in the submucous tissues and the other is between the muscular coats. The spread in this group is unquestionably limited although there must be some spread in a small number of cases by this route. The extramural lymphatics are the more

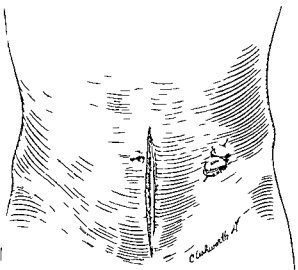


Fig. 3 Median line incision extends above the umbilicus for ample exposure. The colostomy is shown and should be done 2 weeks in advance of the resection.

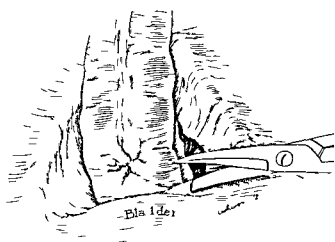


Fig. 4 The peritoneum is incised on both sides of the bowel the incision running down to the bladder. This is a bloodless dissection and permits the identification of both ureters before the operation is carried further. Ample peritoneum is saved without difficulty in the majority of cases for the peritonealization of raw surfaces.

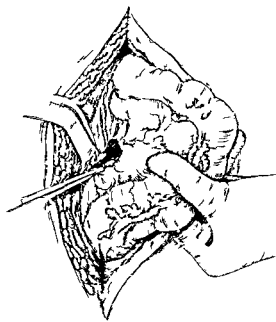
This group carcinoma of the rectosigmoid is like (the included) presents himself after symptoms have been present for a year the low percentage of cases accepted for any type of operation except palliation is not surprising nor is it strange that many patients who are submitted to the two stage or three stage operation are able to withstand more radical procedures with better end results than if the operation were undertaken at a single operation.

Chronic obstruction of the large bowel is a major factor because of the accompanying rapid debilitation, anæmia and desiccation. The chronic absorption not only from the content of the intestinal tract but from the large ulcerating and infected surface of the growth causes a lowered physiological state and this has direct bearing on the outcome of any type of operation. Peritonitis, bronchopneumonia and other post-operative complications which result even from simple operative procedures instituted for the relief of obstruction or for palliation are directly the result of intoxication due to obstruction. Consequently, one of the principal aims of operation is the eradication of the obstruction which perhaps is the most important rehabilitation measure indicated in the majority of instances and is partially accomplished before the first stage of the operation. Although it may be too radical to postulate that all carcinomata of the rectosigmoid and rectum should be operated on by the graded operation, certainly such a procedure is required in the greater number of cases and only in selected cases should the more formidable but highly desirable one stage abdominoperineal resection be undertaken. In this selected group of cases the

abdominoperineal operation performed by the technique of Jones of Boston is ideal. A graded abdominal or abdominoperineal resection permits of more radical procedures with removal of a wider area of infected tissue in a case in which otherwise the risk would be considerably greater. In the absence of metastasis to the liver and fixation to adjacent structures immobility is unquestionably the most significant criterion in the decision as to whether the growth is removable and this immobility is I believe more often the result of inflammatory than malignant changes. Given a drainage operation which permits local treatment and the institution of measures to reduce inflammation one not infrequently finds that a radical secondary operation may be carried out satisfactorily in cases which at the first stage were deemed unsatisfactory for resection.

PRE-OPERATIVE PREPARATION

The isolation of patients with surgical diseases of the colon and rectum under co-operative management in the Mayo Clinic has permitted not only proper pre-operative preparations to be instituted but with increasing experience has permitted better selection of cases for different types of operation. The rehabilitation measures instituted consist of (1) adequate cleansing of the gastrointestinal tract (2) supportive measures such as blood transfusion, increase in fluid intake and general measures to increase the patient's resistance (3) institution of local measures which reduce the inflammatory reactions around the growth (4) proper dietary measures and (5) institution of drainage by colostomy preliminary



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to subsequent resection. The study of these cases and a comparison of immediate results over a short period have shown convincingly that cooperative group management pre-operatively and intraoperatively with proper election of anesthetic and a graded operative maneuver have added materially to the immediate satisfactory operative results.

The routine pre-operative preparation of the bowel itself has consisted of (1) the institution of drainage prior to resection (2) the administration of small doses of castor oil in varying amounts to within 48 or 96 hours before operation and (3) cleansing enemas twice daily until 4 hours before the operation with large amounts of water until it returns clear and (4) during the lav prior to operation paregoric in divided doses of from 1 to 4 drops every 4 hours until 4 doses have been given. This routine almost invariably results in a clean empty bowel and the administration of the narcotic during the last 4 hours has had a decided sedative effect in peristalsis. A diet free from residue and consisting largely of fruit juices and candy has been found satisfactory. Increase in weight frequently has resulted and nutrition has always been adequately maintained.

COLOSTOMY

Perhaps the most important advance in the treatment of carcinoma of the rectum and sigmoid has been the usual tendency to accept permanent colostomy as a necessary step in the procedure. Whether the peritonitis is performed at one or two stages there is small reason for debate of the fact that most patients are better off with the colostomy opening on the anterior abdominal wall where it may be more satisfactorily attended to than posteriorly on the sacrum. In performing colostomy I prefer to explore the abdomen through a split muscle incision palpating the liver and right lymph nodes and the growth in the order named and determine the relative fixity of the growth in the absence of metastasis. The artificial anus is made as high as possible in the sigmoid or cecum. The colon is fed back into the abdomen until its fixed point is reached and here an incision in the transverse mesocolon permits drawing under it of at least the layer of the abdominal wall, the skin and peritoneum. The small fossa lateral to the colon between its mesentery and the parietal peritoneum is shut off by a purse string suture to prevent herniation and obstruction from loops of the small

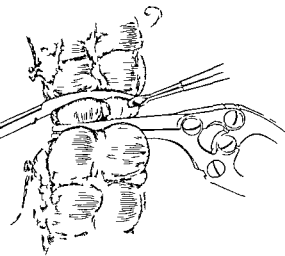


Fig 7 Dividing the upper end of the bowel between clamps with cautery

el which might pass behind it. As the colon is pulled back into the abdomen a trust point is reached which also prevents subsequent herniation of the peritoneal membrane of the bowel and makes it much easier to care for. I do not believe that trust should be placed in the wall of the bowel. Occasionally fecal fistula results in spite of the care taken not to penetrate the lumen and if the stoma is drawn snugly around there is small possibility of necessity of the sutures. The peritoneum and the skin are sutured as separate layers under the bowel. A few interrupted sutures in the aponeurosis of the external oblique muscle all that are necessary except the subsequent approximation of skin. I have seldom observed prolapse as a result of this type of operation. Constriction is likewise satisfactory so long as the bowel is constipated.

The colostomy is allowed to remain closed as long as the patient does not complain of gas distention and frequently gas passes over the stoma out by rectum for as long as 10 days. Usually, however, one must cut across the bowel or at least puncture it to obviate painful distention. One may make this incision any time after 48 hours up to 7 days and then institute thorough irrigations with the idea of cleansing the lower loop of the bowel and reducing infection as much as possible in preparation for the secondary resection. Either physiologic sodium chloride or potassium permanganate of potash solution is satisfactory for irrigation. Probably the removal of the content of the bowel and the thorough washing of ulcerated and infected area account for the reduction in inflammatory reaction rather than use of any particular medicament which may be placed in the solution. At the same time antibiotic measures are forced and the patient

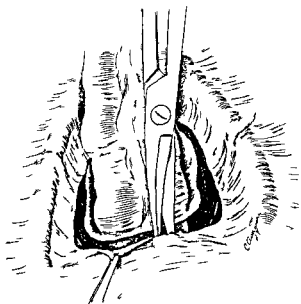


Fig 8 Separating the bladder from the rectum in the male by dividing the peritoneal fold which attaches them

comes to operation in an infinitely improved state from the delay of two weeks and the institution of drainage.

TECHNIQUE OF RESECTION

Usually it has been found advisable to wait from 10 days to 2 weeks after the preliminary colostomy has been performed before the second maneuver of the resection is carried out. The abdomen is opened through a long median line incision which extends to the left of the umbilicus and about 5 centimeters above it (Fig 3). To prevent contamination as much as possible the stoma is sealed off before operation is begun and

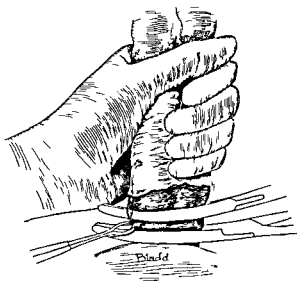


Fig 9 Division of the lower end of the bowel between clamps with cautery

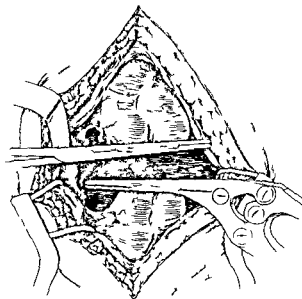


Fig. 4. Operation for the removal of the sigmoid colon. The incision is made in the abdominal wall, and the sigmoid colon is exposed. The mesentery of the sigmoid colon is then divided, and the colon is retracted to the left side of the abdomen.

I believe it is rarely a source of contamination except by superficial wound contamination which is a rather constant accompaniment of any procedure carried out on the large bowel. After the

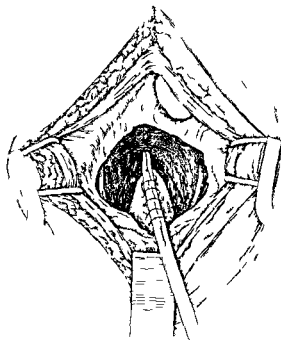


Fig. 5. The sigmoid colon is retracted to the left side of the abdomen, and the mesentery is divided. The colon is then pulled towards the left side of the body, and the mesentery is divided.

abdomen has been opened and its contents in the upper quadrants except the pelvic colon and contents of the pelvis packed away the initial step to insure satisfactory hemostasis is ligation of the inferior mesenteric vessels near the promontory of the sacrum (Fig. 4). The inferior mesenteric artery should be ligated between the superior hemorrhoidal and the left colic branches in order to preserve adequate vascular nutrition to the left colon. The whole of the descending colon, sigmoid and upper part of the rectum derive their blood supply from this artery. It is fairly constant in its distribution save only for its anastomosis with the superior mesenteric which fails occasionally and results in necrosis of the left colon. The arteries of the sigmoid which are branches of the inferior mesenteric vein anastomose with the superior hemorrhoidal and left colic arteries and are not sufficiently disturbed to interfere with the blood supply of the upper part of the sigmoid after a hysterecomy has been placed between the left colic and superior hemorrhoidal vessels (Fig. 5). In ligating the left colic vessel one first retracts the colon toward the left side and incises the peritoneum of its mesentery over the vessel. This exposes the vessels readily and they may then be isolated on a finger. Careful manual

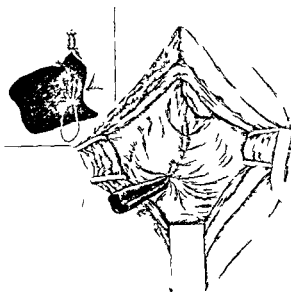


Fig. 6. The sigmoid colon is retracted to the left side of the abdomen, and the mesentery is divided. The colon is then pulled towards the left side of the body, and the mesentery is divided.

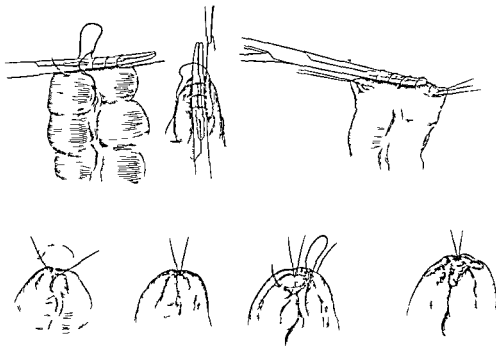


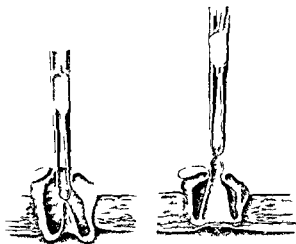
Fig. 13 Steps in the closure of the upper end of the bowel which is really the blind loop on the colo tomy. This is inverted satisfactorily and peritonealized if it is to be left. Ordinarily it is better removed as is shown in Figures 15 and 16.

manipulation of the vessels isolating them together is I believe preferable to elevating them on an aneurism needle or other instrument and is less rarely accompanied by tearing into the vein with resulting venous hemorrhage. The vessels should be freed of fat and carefully ligated twice to prevent them from retracting into the mesentery with an ensuing hemorrhage or at least a large and undesirable hematoma. The initial incision on the right side in the peritoneum of the mesentery of the pelvic colon is now carried forward to the bladder with retraction laterally to expose the right ureter. A similar incision is made on the left side after the sigmoid is retracted toward the right and the left ureter is likewise identified (Fig. 6). I believe the identification of the ureters is an important step and if possible should always be observed.

When both ureters have been identified and the blood supply has been ligated the dissection of the hollow of the sacrum follows easily and is readily done with the hand. If the hand is introduced at the point of ligation of the inferior mesenteric blunt dissection may be carried back to the fascia covering the hollow of the sacrum and the dissecting fingers carried forward and downward until they may be felt to jump off the end of the coccyx. This is about as low as posterior dissection may be done. It is surprising how infrequently there is any bleeding accompanying this step. Except for a few veins which

are sometimes troublesome whether one does an anterior or posterior resection there is rarely any bleeding and never any of consequence. A hot salt pack placed in the hollow of the sacrum once its contents are dissected controls any oozing which may be present.

The next step in the procedure is to free the sigmoid from its peritoneal attachments to the bladder. Starting on the right side with scissors dissection I cut across the peritoneum which joins the two viscera and separate them readily. If the ureters have been identified previously there is no question of injury either to them or to the base of the bladder itself (Fig. 7). Occasionally a sigmoidal growth will be found attached to the posterior wall of the bladder and it is necessary to take away the outer coats of this viscus in the dissection. If the mucous membrane of the bladder is not opened there is no complication from this step. After the attachments of the vesicosigmoid have been separated by blunt dissection laterally and anteriorly the rectosigmoid and upper part of the rectum are freed down to a point within from 5 to 7.5 centimeters of the anal orifice (Fig. 8). It is surprising how far down one may carry this dissection and remove practically the whole of the rectum with the sigmoid leaving only a small stump. It is advisable to do the complete dissection in most instances before the sigmoid is cut across at its upper end yet when the growth is attached and dissection is some



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what difficult it may be better to divide the sigmoid and use the upper portion as a tractor for exposure and to aid in the completion of the dislocation.

The bowel is now removed between two clamps at both ends (Fig. 9). In this manner there is a large amount of bowel sacrificed and all the gland bearing tissues the upper and lateral lymphatic zones of Miles are removed with it. There remains only the problem of furnishing peritoneum for the pelvis of making a new pelvic floor of turning in satisfactorily the lower end of the rectal stump and of dealing with the distal end of the sigmoid beyond the stoma (Fig. 10). These three steps are more easily accomplished than would be expected particularly the step dealing

with the rectal stump. Although the end of the bowel is deep in the pelvis and far from accessible one may by using an over and over type of suture such as is used in dealing with the duodenal stump following gastric resection turn it in satisfactorily and place accurately at least two layers of sutures (Fig. 11). This is usually done with trannic acid catgut on curved needles reinforcing with a few interrupted silk sutures. The pelvic peritoneum has been mobilized at the location of the inferior mesenteric vessels in such a manner as to leave ample reflection on either side to join in the median line so that a new floor for the pelvis is made. I have not encountered difficulty in saving enough peritoneum satisfactorily to close over the male pelvis and in the female pelvis it is a relatively much simpler procedure because the uterus and adnexa may if necessary be drawn over and sutured to the promontory of the sacrum in case there is a gap in the peritoneum (Fig. 12).

There is the disadvantage however in both instances of a large dead space in which serum will certainly collect and which is potentially infected from the manipulation of the bowel. This space is always drained but not for long or very effectively. Two small rubber tissue drains are usually ample or at most one cistern tube. In the female drainage is much simpler and is always secured through the vagina. This reduces the mortality of operation considerably over that of the male when drainage must necessarily be secured through the abdominal wound (Fig. 13). The question of draining through the rectal stump is one to be distinctly deprecated in any case. The upper end of the sigmoid or the small blind pouch which lies below the stoma may be dealt with satisfactorily in two ways either by removal or leaving it *in situ*. I usually leave it after invagination with catgut and silk and putting over whatever fat tags are conveniently near but occasionally it has seemed advisable to remove it. I do this after ligating the blood supply up to the peritoneum and by simply invaginating it on itself through the abdominal wall and leaving it for subsequent removal when it is adequately sealed off (Fig. 14). After the operation has been completed an assistant with an instrument attached to the end of the blind pouch pushes it into itself and out through the abdominal incision where the surgeon may grasp it and by traction bring it entirely out leaving it attached so that there will be no contamination from this step. A few sutures placed in the peritoneum behind it preclude any difficulty from contamination (Fig. 15 frontispiece). The abdominal wound is now closed and the stump is allowed to

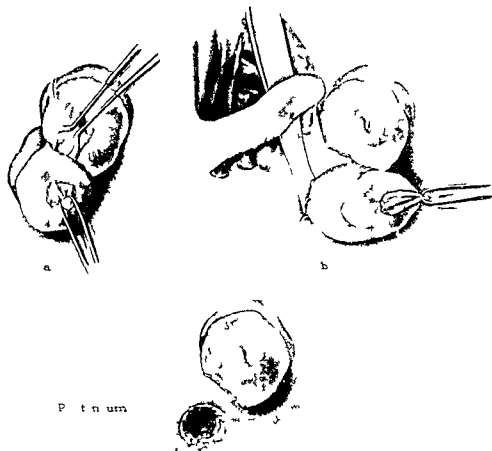


Fig 16 a Division of the mesentery and separation of the two loops of bowel with cautery b Blunt dissection with handle of knife separating lower segment which is to be removed from skin and underlying tissues c Appearance of wound from which lower loop was excised immediately after its removal

hang *in situ* for about 10 days when it is removed easily and simply by cautery. I believe that this step while possibly making the operation a little more serious may not be unwise since there is a question of the blowing out of the end and the producing of peritonitis (Fig 16). This has been observed occasionally and apparently was a factor in the one death in my series of 26 cases.

RE ESTABLISHMENT OF THE LUMEN OF THE BOWEL AFTER RESECTION

The question of re establishment of the continuity of the bowel following resection is one which the surgeon is forced to decide in each case because of the almost universal insistence by the patient that the muscular mechanism controlling defecation be preserved and the colostomy be abandoned subsequently. Occasionally a patient is so insistent that operation is refused unless this requirement be met and if the growth is above the peritoneal fold and there is no lymphatic involvement perhaps one is justified in restoring

the normal intestinal canal occasionally. As a working rule unquestionably carcinoma at the rectosigmoid and below is best treated by colostomy high in the sigmoid and subsequent removal of the entire bowel or at least all except the anal canal below the stoma. Anatomical types influence this decision markedly however and no one standard operation is applicable to all cases in this group. Individualization occasionally will demand after colostomy re establishment of the continuity of the intestinal tract. The important technical question in deciding this is the blood supply to the lower segment. After the inferior mesenteric vessels have been tied above the superior hemorrhoidal branch practically the whole blood supply to the lower segment and the rectum is sacrificed and yet studies of the collateral circulation and actual clinical experience bear out the observation that if a portion of the rectum is saved and the continuity re established if the blood supply to the upper segment is adequate necrosis and sloughing will rarely result. In this

ture of anterior resections. I reestablished the continuity of the bowel in only one instance. The patient was the wife of a physician and both she and her husband insisted that this type of operation be carried out. Fortunately there was no lymphatic involvement discovered at resection and it seemed not unwise to agree to their demand. The reestablishment is not difficult (despite the fact that the lower loop is deep in the pelvis) and may be accomplished quite accurately with two or even three layers of sutures with a good outlook for success. The fact that there is no tension in the suture line from the colostomy opening alone and that any stricture in the segment may be removed by a rectal tube is decidedly advantageous to healing and with the exception of infection which is outside the lumen of the bowel there are few factors which prejudice success. As a general rule however this anastomosis should be deprecated but unquestionably there are occasional exceptions favorable for its use.

REMOVAL OF RECTAL STUMP AT THIRD STAGE

A further modification in which has been employed several times in this series of cases is the removal of the blind pouch of rectum as a third stage to the operation. It is not certain whether this step might not be employed as a routine, the only argument against it being the low morbidity which in reality is not an argument in dealing with carcinoma. It makes the operation more radical and prevents the convalescence but it has been advantageous in the few instances in which I have done it. The first time it was necessary to remove the stump, days after the second operation. An abscess formed in the pelvis making drainage highly essential and the easiest way to establish it seemed to be by excision of the rectal stump. This was done by the sacral incision and was a simple procedure requiring only a few moments. Sutures were not used in the wound healed rapidly. Perhaps it would be an advantageous addition to the entire procedure at a third stage under local anesthesia. There has been practically no trouble from this stump when it has been left in situ and in only two instances in the 6 cases did it drain into the sinus established by the abdominal drainage tube. In both instances the drainage of mucus by the low drainage of the rectum ceased without incidence.

ANESTHESIA

Spinal anesthesia was employed as a routine in all cases. Its advantages are so marked that its

continuance is at least indicated in this type of operation. The freedom from pulmonary complications, the relaxation and the lack of oozing at the time of operation facilitate more satisfactory exposure and accurate technique.

SUMMARY

From March 30, 1917 to February 1, 1928 I performed 26 anterior resections of the rectosigmoid and upper rectum by the technique described with one death. In this instance the patient was a man aged 68 with an easily removable growth. He died on the fifteenth day after operation after having been out of bed for 2 days and without symptoms referable to the abdomen. His bowels were active, he was eating well and his progress seemed perfectly satisfactory until he was seized suddenly with symptoms of abdominal crisis and died 6 hours later. Necropsy disclosed plastic peritonitis which probably is present to a certain degree in practically all of such cases. There was no other satisfactory explanation for his death.

My experience with this series has been so satisfactory from the standpoint of the technique as well as operative mortality and morbidity that I am encouraged to continue this type of operation either alone or with the modification suggested, namely removal of the lower segment either at the same stage or as a subsequent and separate maneuver. Certainly it seems justifiable to hope for encouraging end results in the light of the radical procedure made possible by the multiple stage operation. The reduction of mortality is a striking example of what may be accomplished by co-operative measures in this group of cases and the adequate rehabilitation measures combined with spinal anesthesia and graded operation apparently encourage the prospect of a widespread removal of the growth and contiguous tissues with a lower death rate and a favorable outlook.

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FROM THE DIVISION OF SURGERY JACKSON CLINIC

THYROIDECTOMY I

By ARNOLD S. JACKSON, M.D. Meticulous W. CONSEN

NO single condition is responsible for the dangers and possible complications to be feared in performing thyroidectomy. A number of factors should be considered such as the age of the patient, the duration of the disease, the extent of impairment of the cardiovascular renal system, the condition of the patient, the kind of goiter, the skill and experience of the surgeon, and the choice of anæsthetic.

Until 1922 when Plummer suggested the use of iodine in connection with surgery in the treatment of exophthalmic goiter, postoperative hyperthyroidism was the most dreaded of all surgical complications. Frequently, in spite of weeks or months of preparation and multiple stage operations performed with acumen and skill, the patient developed a high pulse rate and fever together with vomiting and delirium and succumbed a few hours after operation. Since 1922 no deaths have occurred at the Jackson Clinic as a result of postoperative hyperthyroidism in spite of the fact that only one ligation has been performed during the past 4 years. There have been a number of instances of severe reaction but in every case this condition has been controlled by the methods which I shall describe.

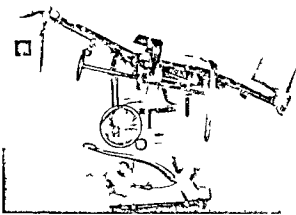
In exophthalmic goiter, the most fearful complication in my experience and probably in the experience of every surgeon interested in surgery of the thyroid is that of involvement of the recurrent laryngeal nerve. In some instances the surgeon is probably not directly responsible because the mere stretching or compression of the nerve by oedematous or scar tissue may cause trouble. Since it has been determined that failure in the past to effect cure for this disease was due to the preservation of too much gland tissue, most surgeons are now advocating a more radical removal of the gland. Consequently there is greater danger of involving the nerve either by a hæmostat or suture unless cure is exercised to remain within the capsule. This expression has become almost stereotyped in descriptions of the operation for goiter and might perhaps well be discarded. In many cases of exophthalmic goiter the gland is so friable and vascular and the capsule so thin that it is scarcely visible and the surgeon is fortunate to be able to reflect the gland and control hæmorrhage. In adenomatous goiter

there is frequently a tough fibrous capsule and the operation is a much simpler procedure.

Two of my patients were successfully operated on and were able to converse freely before leaving the operating room. A few minutes later they were reported to be cyanotic and dyspnoic. Unconsciousness quickly followed but the condition was promptly relieved by removing the bandage and opening the wound, forcing the chin down on the chest and administering oxygen. Convalescence was uneventful, a secondary wound closure being made in 24 hours. Since laryngeal examination showed no involvement of the vocal cords and the trachea was not collapsed, these near fatal complications have been attributed to sudden paralysis of the nerves from change of position and consequent severe tension.

If only one recurrent laryngeal nerve is injured, the other will usually compensate so that after a few days or weeks the voice is restored to normal. Even if bilateral adductor paralysis of the vocal cords occurs, tracheotomy may not be necessary, but if bilateral abductor paralysis occurs the increasing stridor, cyanosis and dyspnoea necessitate this procedure. There should be no excuse for the occurrence of such a complication yet there have been many instances in the past and with the increasing number of inexperienced surgeons performing the operation there will be more in the future. Too frequently this complication has been considered as tracheal collapse, a condition I have yet to observe.

Barring nerve injury, then death should not occur following operation for exophthalmic goiter unless it is from tracheitis developing into pneumonia or from hæmorrhage or the more unusual complications such as embolism, tetanus and tetanus. In spite of preservation of the tracheal fascia and of care in handling fatal tracheitis may occur. Hæmorrhage, although it is frequently severe at the time of operation in the large friable vascular glands of long standing, is seldom dangerous and usually is controlled by elevation and compression of the gland by the index finger. Injury to the lateral or jugular veins may prove more troublesome. Postoperative hæmorrhage is evidenced by restlessness, dyspnoea, cyanosis and increasing pulse rate. The diagnosis is made by examination of the neck, which usually



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Cirrhac failure is seldom a serious complication in exophthalmic goiter except in cases of long standing. The condition of the heart can usually be regulated by iodine and digitalis. In toxic adenoma however chronic myocarditis is the most important condition to be considered and cardiac failure is the complication to be most feared. However when the disease is of short duration the surgeon experienced the anaesthesia local and the pre operative preparation correct the patient obviously has an excellent chance for recovery and no complication should be feared.

PREL OPERATIVE PREPARATION

The pre operative preparation of patients in these cases depends on the kind of goiter and the condition of the patient. In non toxic adenomatous goiter no preliminary treatment is required other than to determine that no contraindications to operation exist such as diabetes and tonsillitis. However since extremely large adenomatous goiter is frequently substernal or intrathoracic and consequently exerts considerable back pressure on the heart it may be advisable to give the patient several days rest in bed and to give diuretics.

In toxic adenoma it is a different story. At the present time there exists a greater divergence of opinion regarding the preparation of these patients for operation than at any time in the past. It makes little difference what method is used even in the most skilled hands there is a definite mortality of from 1 to 5 per cent. The care of the patient is the most serious problem confronting the surgeon who is especially interest-

ed in goiter surgery. Until about 1900 years ago Plummer advocated the routine digitalizing of these patients. Then he stopped the use of digitalis and stated that a considerable lowering of the mortality had resulted. Some have felt that actual clinical experience warranted the continuation of the use of digitalis. Among the institutions supporting this view are the Cleveland Clinic, Lahey Clinic, Henry Ford Hospital, University of Michigan, and the Jackson Clinic.

Dunn in the past year four deaths have occurred following operation for goiter in our Clinic. Two of these patients had toxic adenoma of long standing in which serious damage to the cardiovascular renal systems had occurred. I have often wondered whether if digitalis had not been given these patients would have survived. Likewise I have wondered whether some of the other patients who presented equally poor risk would have survived if digitalis had not been used.

There also exists great difference of opinion regarding the use of iodine in these cases. Cline, Graham and others who support the view that exophthalmic goiter and toxic adenoma are one and the same give iodine. In my own experience I have not found iodine beneficial in cases of uncomplicated toxic adenoma. I believe that seeming success has been due to the fact that in one of every four cases of exophthalmic goiter adenomatous nodules may be found. In other words a patient may have adenomatous goiter of many years duration that has never become toxic. A few months before he consults his physician exophthalmic goiter is superimposed. Iodine is

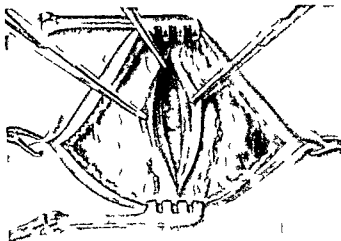


Fig. 3 Median incision through the fascia and muscles to the gland

given supposedly for toxic adenoma and there is immediate improvement. This error will continue to be made until the clinical differential points between exophthalmic goiter and toxic adenoma are clearly understood. Rest in bed, a high caloric diet, sedatives, and general symptomatic treatment are indicated. No patient should be allowed to become bedridden but after a few days absolute rest should be encouraged to walk around and build up for the operation.

The use of iodine has revolutionized the pre-operative preparation of patients with exophthalmic goiter. Four years ago I gave up ligation and stage operation and whenever possible allowed the

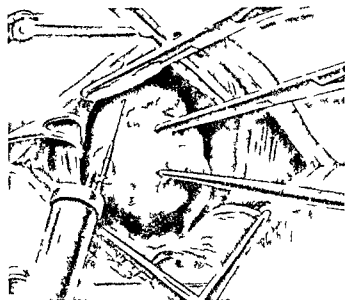


Fig. 4 Injection of novocain into the superior pole after the muscles have been divided and the gland is exposed

patient to prepare for operation at home. This is not so successful as preparation in the hospital since the conditions are necessarily not identical but it is a great financial help to the patient. Many patients of course must be hospitalized and even kept in bed for several days if there is cardiac decompensation or gastro-intestinal crisis. The old idea of keeping these patients in bed for weeks is wrong. No matter in what condition my patients come I never permit more than a week's rest in bed. Ninety per cent of them are operated upon within 10 days from the time they are

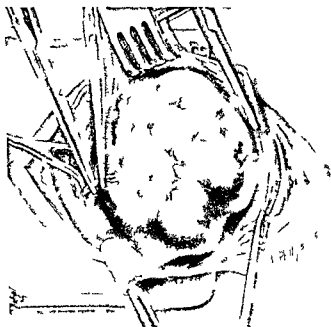


Fig. 5 Separation and division of lateral veins (one of the most important steps of the operation)

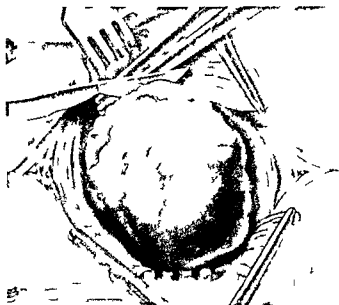


Fig. 6 Double clamping of the superior thyroid vessels and division of pole allowing easy mobilization of the gland



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admitted. In 19 I showed that the average drop in the basal metabolic rate within this time was 60 points. I provided large doses of iodine were administered. I have always maintained that more satisfactory results could be obtained in a shorter time by saturating the gland with iodine than by merely using 15 drops a day. In the average case 60 drops a day is given but two or three times this amount may be used for patients admitted in crisis. All my patients receive a high caloric diet (about 4000 calories a day). Only the use of coffee and tea is restricted. They may eat all the beefsteak, all the cake and candy they will and in fact anything they desire so long as they eat.

Patients are routinely given 60 drops of the tincture of digitalis three times daily for 3 days. A half grain of phenobarbital is given three times daily. These drugs are not essential but are a matter of individual choice.

Next to iodine therapy I believe that the psychological factor is most important in handling these patients. I never operate unless the patient fully understands his condition and knows the time and reason for operation. He gains confidence by talking with others who have undergone operation. Crile employs another form of psychology, that of stealing the gland. Both methods apparently yield equally good results but it should be understood that these patients cannot be handled by ordinary method. It is the little things that make the big things in goiter surgery.

It is a mistake to starve the patients on the morning of operation. If iodine and food are withheld for several hours before operation it is



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only natural to suppose that the metabolism will be greatly increased, that the postoperative reaction will be severe and that acidosis may occur. Our patients receive 60 grams of glucose with orange juice as is given to diabetic patients an hour before operation and iodine is administered continually.

THE OPERATION

When the patient's condition has been judged fit for operation, he is so informed and perhaps is given an additional sedative on the night preceding operation. An hour before operation 3 grain morphine is given hypodermically and 15 minutes later 1/300 grain of scopolamine. The room is darkened and no relatives are permitted to come in. The patient's eyes are bandaged, vaseline cotton is inserted in the ears, and he is encouraged to sleep. When he is brought to the operating room 1/6 grain of morphine is given hypodermically. This usually insures perfect anesthesia when combined with novocain.

The position of the patient on the operating table is of considerable importance. I recently devised a table that I feel gives the best exposure of the operating field and at the same time assures the maximal amount of comfort for the patient (Fig. 1). The preparation of the skin is a matter of individual choice and it makes no difference

whether iodine picric acid or mercurochrome is used. Opinion is about equally divided regarding the anæsthetic some surgeons prefer nitrous oxide others ethylene and still others novocain. In my experience the latter following hypodermic injections of morphine and scopolamine has given excellent results in fully 98 per cent of my cases this method has been used. The advantages are that the surgeon has the patient under his control the patient can be made to talk and to cough the possibility of injury to the recurrent laryngeal nerve is consequently lessened the danger of post operative pneumonia is almost eliminated and in the case of removal of large substernal goiter dyspnoea is better controlled. The disadvantages are that if the patient is extremely apprehensive the operation is more taxing both on the patient and the surgeon. In my experience non toxic patients are frequently more nervous than the extremely toxic patients. Postoperative vomiting and reaction are materially reduced by the use of local anæsthesia. The infiltration method is preferable to nerve block because it is simpler and more speedy. One half of 1 per cent of novocain with no adrenalin is satisfactory. An all metal modified Meeker syringe that I have devised has proved helpful (Fig. A).

In thyroid surgery perhaps more than in any other teamwork is essential and the service of two skilled assistants is desirable. Likewise the surgical nurse should be unusually keen and alert since accuracy and intelligent co-operation may play an important part in the success of the operation. There is no talking during the operation and quiet is secured by covering metal surfaces in the operating room with rubber.

The instruments required for the usual goiter operation are several dozen Kocher (large or small) Crile or Lohy hemostats as preferred one dozen small curved clamps a grasping clamp (Fig. 2 C) sharp and dull retractors a self retaining retractor four muscleclamps two needle holders one dozen towel clips and four sharp scalpels.

When the incision is made the scalpel must be carried at right angles to the skin the entire distance otherwise the upper flap will override. The incision should if possible be made in a fold of the neck and should be fully an inch higher than is ultimately desired for the scar. The length of the incision will depend on the size and consequently the type of goiter. It should be slightly curved and its lowest median point should be at least an inch above the suprasternal notch. (Some surgeons prefer to outline it first with a colored solution or the back of the knife.) The incision should be made with a free clean sweep and made

at once through the skin the platysma myoides and to the superficial fascial layer. The flaps are then dissected free to give adequate exposure and the superficial bleeding points are ligated. Among the various types of self retaining retractor to hold the flaps in place is one which I have devised for this purpose (Fig. 2 B). A split towel protects the wound. Occasionally it may be advisable to ligate separately the external jugular veins. A median or slightly lateral incision is then made through the cervical fascia and underlying muscles to the thyroid gland. The sternohyoid and sternothyroid muscles are next elevated from the capsule of the gland by blunt dissection. Whether or not these muscles are to be divided is a matter of individual choice. In many cases I prefer to divide them as I feel that the greatly improved exposure more than compensates for the time lost. Haste is less essential than is a careful resection of the gland. If the goiter is large or friable and vascular there is danger of injury to the nerves or parathyroids if there is inadequate exposure. In many instances it may be necessary to divide the muscles on but one side. Novocain should be injected into the muscles before they are divided.

When the gland is exposed it should be injected and then elevated. At the same time the capsule should be separated by either blunt or sharp dissection. Care should be exercised to avoid tearing the lateral veins and these should be separately ligated. The gland having been freed from its bed the upper pole is exposed and the superior thyroid vessels located. These are double clamped and then divided. Whether or not the vessels are secured by means of an aneurism or a regular needle is immaterial and whether plain catgut or silk is used is merely a matter of choice. The important point is to ligate the vessels securely so that they cannot retract and cause hemorrhage. When the upper pole has been divided the gland is easily mobilized. Some surgeons now prefer to free the gland from the trachea a procedure that should always be carried out in case of large substernal goiter. Others prefer to proceed by placing hemostats laterally on the gland after the method of Halsted. It is a safe plan to leave some gland tissue below the clamp at the lower pole. The gland is then resected the assistant clamping the vessels as they are about to be divided. The amount of tissue to be preserved depends on the type of goiter a much smaller portion is preserved in the exophthalmic type than in the others. Next the vessels are ligated and a few interrupted sutures may be used to control the hemorrhage. If the isthmus has not already been resected this

is now done and the same procedure carried out with the left lobe. The tracheal fascia should be preserved intact since its removal leads to distressing tracheitis.

After the gland has been resected the patient is asked to cough and strain so that any possible bleeding points may not be overlooked. If the wound is dry the divided muscles may be approximated. In uniting these muscles in the median line interrupted sutures and separate closure for the fascia are preferred (Figs 3 to 7).

There is considerable difference of opinion regarding the question of drainage. I am convinced from the experience of others and from observation that some kind of drain should be inserted because of the danger of infection and of mediastinitis. Some surgeons prefer lateral to median line drainage, some prefer rubber tubes and others gutta serena. Some likewise advocate silk in skin closure, others dermal and still others clips. I have tried all methods of drainage and skin closure and have a particular preference. Apparently an interrupted closure of the platysma myoides and of the skin gives better results (Fig. 8). Too much care cannot be exercised in an effort to produce a perfect scar. The type of dressing used is immaterial as long as it is comfortable and sufficient to protect the wound and prevent swelling from drainage.

It seems almost unnecessary to say that the tissues should be handled with the greatest gentleness since thyroidectomy cannot be successfully performed under local anesthesia unless this surgical principle is observed.

POSTOPERATIVE CARE

The patient should be placed in bed in a semi-upright position and made comfortable with plenty of pillows. Tap water is given routinely by proctoclysis in case of exophthalmic goiter. 10 drops of Lu's solution is added to each 500 cubic centimeters of tap water. In the evening it is essential that sufficient iodine be administered both by mouth and by rectum to control the postoperative reaction. During a period of 6 hours before and after operation my patients receive 100 drops or more of iodine well diluted. The amount given thereafter depends on the severity of the disease and the severity of reaction. Vomiting, tachycardia, fever and restlessness may all be present but when they are exaggerated a severe reaction is indicated. The proper preoperative preparation and the use of iodine will control all these symptoms.

Toxic adenoma offers a more difficult problem. The operation may have been performed speedily

and with little apparent disturbance to the patient. The latter returns to the room seemingly in good condition. The next day the pulse rate may be irregular, the patient's mind rather cloudy and in spite of all efforts to the contrary another day may see the fatal termination of the case.

It does not seem necessary to say that the intake and output of fluid should be carefully observed that in case of tracheitis a steam tent should be placed around the patient and that excessive mucus may be controlled by administration of codein and small doses of atropin together with digitalis hypodermically. Phenobarbital and codein will usually control nervousness if this fails morphine may be given.

POSTOPERATIVE COMPLICATIONS

Since the most frequent postoperative complications have already been discussed it is necessary to mention only the treatment of these conditions.

Injury to recurrent laryngeal nerves. If one recurrent laryngeal nerve has been injured temporary loss of voice usually occurs. More distressing are the dyspnoea and mucus. Codein, atropin and steam inhalations of benzoin are helpful. If both nerves are damaged so that bilateral abductor paralysis of the vocal cord occurs it will probably be necessary to perform tracheotomy.

Hæmorrhage. As soon as hæmorrhage is suspected the patient should be returned to the operating room if time permits. There the wound may be opened under ideal conditions the blood clot removed and possibly the bleeding vessel ligated. If the vessel cannot be readily located without risk of injury to the nerves the wound should be packed and left open for secondary closure.

Every interne and nurse coming in contact with goiter patients should be familiar with the signs of postoperative hæmorrhage since prompt action may save a life. Dyspnoea may develop so rapidly that it is necessary to remove the bandage and open the wound with whatever is at hand. Prompt action and the administration of oxygen are indicated.

Tetany. Postoperative tetany is an unfortunate complication especially if it is the chronic type. I recently made a study of this subject and reported several cases (2) in the hope that it might stimulate an interest in this problem and possibly lead to more satisfactory methods of treatment. It is evident that the radical type of thyroidectomy necessary to obtain cure and prevent recurrence

has resulted in an increased incidence of postoperative tetany. Practically every surgeon that has performed a considerable number of thyroidectomies has encountered this complication and yet considering the enormous amount of literature on goiter this subject has received but slight attention. There seems to be an inclination not to discuss unsatisfactory results.

The onset of postoperative tetany may be acute or chronic. Headache radiating pains down the extremities, chronic twitching and stiffness in the hands and feet are early symptoms. The extremities tingle and become numb, the face becomes stiff and distorted spasms develop in the hands and often in the feet. The hands may assume the typical contraction of the accoucheur's hand. The diagnosis may be confirmed by eliciting attack through pressure over the main nerve trunk of the forearm (Trousseau's sign) or by tapping the facial nerve and causing the muscles of the corner of the mouth to twitch (Chvostek's sign).

In my experience calcium administered either orally or intravenously has proved entirely satisfactory in controlling the attacks of tetany in all but one patient. In this case Collip's parathormone injected intravenously proved most beneficial. In the five chronic cases which I reported neither of these remedies effected cure. However one patient has shown remarkable improvement following ultraviolet light therapy and I have been sufficiently encouraged to follow this lead.

Embolism. Fortunately embolism is a rare complication in surgery of the thyroid. I know of two fatal cases of air embolism, one following ligation and the other following thyroidectomy. It should be borne in mind that the veins of the thyroid do not readily collapse and that they are valveless and consequently air is quickly aspirated. All bleeding points should be securely ligated.

Pneumonia. If operation is done under local anesthesia pneumonia can be almost excluded as a complication and now the advent of the oxygen chamber promises to reduce still further the dread of this complication.

Infection. The incidence of infection following thyroidectomy is considerably lower than in abdominal surgery. In fact if proper drainage has been supplied infection rarely occurs. I believe that the wound should be probed daily at the site of the drainage tract and the neck lightly massaged. If the neck appears indurated and firm proper drainage is not being secured and moist warm dressings should be applied at frequent intervals. If pus appears healing is naturally delayed and a disfiguring scar may result.

PROGNOSIS

If sufficient tissue has been removed a recurrence may be expected in not more than 2 per cent of cases of adenomatous goiter. This factor is dependent on age; the younger the patient the greater the possibility of recurrence. Usually solitary cystic adenoma will enlarge and if detected early may be removed through a small incision. Adenomata in the region of the isthmus beneath the mandible or behind the trachea are frequently overlooked and are the cause of recurrence. Naturally when only lobectomy has been performed there is a strong possibility that recurrence will result. Some surgeons have stated that in resecting the gland it is necessary to remove all adenomata. I consider this impossible unless complete thyroidectomy is attempted since in many instances the entire gland appears to be made up of minute adenomata.

A higher incidence of recurrence may be expected in exophthalmic goiter. In 1920 I assisted Judd in reviewing the postoperative results in two selected groups of patients operated on for goiter at the Mayo Clinic. It was possible to trace 90 of 100 patients who had been operated on for exophthalmic goiter; 66 per cent of these were free from all signs of the disease 6 years after operation; 13.3 per cent were markedly improved and 5.5 per cent were slightly improved. Eleven of the patients died after leaving the Clinic. These operations were all performed before Lugol's solution was being used and on account of greater risk it was not always possible to remove as much tissue as can now be done. Recently I made a study of 300 cases of patients with exophthalmic goiter on whom I had operated and although the time elapsed is too short to pronounce cure in only one case did the patient state that no improvement had resulted. In 95 per cent they reported that they were cured or greatly benefited; the remainder stated that their condition was improved. A number of these cures resulted only after a second thyroidectomy, the primary operation having been performed either by other surgeons or by myself. This should be encouraging for the surgeon and should refute the claims that exophthalmic goiter cannot be cured by thyroidectomy. In my opinion however cure does not mean operation alone but includes a careful post-operative regimen for a year or more.

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DERANGEMENTS OF THE KNEE JOINT WITH SPECIAL REFERENCE TO THE RÔLE OF THE INTERNAL ALAR LIGAMENT IN TEARS OF INTERNAL SEMILUNAR CARTILAGES

By MAURICE BEAUSTEIN M.D. I.A.C.S. CHICAGO

ALTHOUGH there is quite an extensive literature dealing with internal derangements of the knee joint the subject is always of interest to surgeons not only because these derangements are constantly met in industrial surgery demanding correct recognition and treatment but also because the newer phases and different aspects from which derangements of the knee joint can be viewed are matters that are open to considerable discussion.

Derangements of the knee joint were recognized long before the era of the roentgen ray. As early as 1773 William Bromfield described the existence of cartilaginous bodies in the knee and William Hay and John Hunter were also early contributors to this field of pathology.

The roentgen ray has not been of very great service in adding to our knowledge of internal derangements of the knee joint. The roentgenogram of value only when gross bony or dense cartilaginous changes exist but for investigation of displacements of the semilunar cartilages and in derangements which are brought about by changes in the supporting ligamentous structures and the synovial membrane the roentgen rays actually offer but very limited assistance.

Study of the knee joint has been carried out by most investigators on preserved limbs. The operating room offers but little opportunity for exact study of the tissues *intra vitam* since in knee joint surgery it is imperative to avoid all unnecesary manipulation. Therefore in order to study the structures and tissues in a condition approximating those in the living subject it is necessary to carry out the anatomical investigations in the cadaver before post mortem changes have taken place.

For the foregoing reasons and in order to obtain reliable data on knee joints were studied soon after death. An attempt was made to simulate the various traumatic derangements and to visualize the mechanical effects upon the joint. It is only through a proper understanding of the anatomical structures of the knee joint their relation to one another and the pathology considered in the light of a careful clinical history that a diagnosis of a torn cartilage can be established.

ANATOMICAL CONSIDERATIONS

In proportion to its size the knee joint is the most loosely constructed of all the joints. This applies to its bony architecture. The parts of the articulation which are apposed to one another are the spine of the tibia and the intercondylar notch held together by the crucial ligaments. The articulation when deprived of its supportive or binding structures becomes unstable in every position and depends therefore for its stability and integrity upon the ligaments and muscles which bind it. The articular surfaces of the tibia and femur do not come in contact over a large area in any position and in full extension a considerable space is created on either side of the joint on account of convex surfaces of the femoral articulations. These spaces are filled in by the semilunar cartilage—two crescentic disks broad on their external surface and tapering internally decreasing in thickness so as to form a wedge. The semilunar cartilages stabilize the knee when it assumes the extended position and so prevent it from bending laterally. This stability is reinforced by the lateral ligaments—the internal lateral ligament aiding the external semilunar cartilage and the external lateral ligament aiding the internal cartilage. The semilunar cartilages as the name implies are semicircular remains of a complete interarticular fibrocartilaginous disk with its center worn through (Whitlocke) so there are left sharp free edges directed toward the center of the joint. The peripheries are thick and are attached on their external surfaces to the capsule. Both lose the cartilaginous character at their extremities and become fibrous. It is at this fibrocartilaginous junction that fractures or tears usually occur. The attachments of the semilunar cartilages are important from the traumatic standpoint. The internal cartilage is attached in front by the coronary ligament a modification of the capsule to the non-articular surface of the tibia immediately in front of the tibial attachment of the anterior crucial ligament and in addition by the transverse ligament to its fellow on the opposite side. Britton calls attention to the difference in length of the two coronary ligaments and believes that the frequency of displacement of the internal cartilage is due to the immobility of that cartilage as a result of its more firm fixation by the

coronary ligament The external coronary ligament is 10 millimeters in length while the internal is 6 millimeters in length This suggests to Bristow that the external cartilage is allowed more mobility than the internal and is possibly a factor concerned in the relative infrequency of damage to this meniscus The security of the anterior cornu of the internal semilunar cartilage is often exaggerated since that particular portion of the cartilage is more or less free

The external surface of the internal semilunar cartilage is firmly fixed to the inner portion of the internal lateral ligament and also throughout its external border to the capsule This area of fixation appears to be the point of contention to many observers and is held responsible or at least as a contributing factor in the injury of that cartilage Tenny Sir Robert Jones Henderson Fisher and others are firm in this belief The fact that the internal semilunar cartilage has two fixed points one posterior the other lateral and that the anterior horn is more or less insecure contributes in a measure to its liability to injury

The semilunar cartilages move with the tibia in flexion and to a slight extent with the femur in rotation of the knee That this movement occurs at the end of extension and in extreme flexion is an important fact in connection with the adjustment of a displaced cartilage and will be referred to later Surls and Osgood give a splendid explanation of the movements of the semilunar cartilages The semilunar cartilages are arranged so that they slide centrally when the joint is flexed and peripherally when it is extended so that the articulating surfaces are kept in contact at all times and a stable joint is maintained All four extremities of these cartilages are attached firmly near the middle line of the joint The portions between these extremities are attached to the joint capsule Thus there is a constant pull inward on the part of the attached extremities and an outward pull by the intervening capsule But the pull inward is the stronger and so the cartilages are held in apposition with the femoral articular surfaces When the quadriceps contract the joint extends and at the same time the capsule is drawn tense The capsule transmits this pull to the semilunar cartilages and draws them out of harm as the joint is extended

The external lateral ligament is a thin fibrous band stretching from the outer surface of the external condyle of the femur immediately above the popliteal groove splitting the biceps tendon to become inserted into the head of the fibula It is separated from the external semilunar cartilage by the popliteus muscle which passes between it

and the cartilage from in front backward This muscle adds considerable support to the external lateral ligament The tendon of the popliteus muscle is surrounded by a synovial sheath and in its course sweeps past the outer surface of the external semilunar cartilage just behind its center producing a well defined groove in the cartilage At this point the cartilage is therefore covered by synovial membrane This is the only portion of either cartilage that has this arrangement (Fisher)

At this point so called ganglionic cysts of the semilunar cartilage develop Phemister described such cysts and reported cases He cites Ollershaw who found that an endothelial lining was present in some of the cyst cavities and concludes that these cysts might arise from misplaced endothelial elements that form the joint lining

Figure 1 shows the external lateral ligament and its relations to the popliteus muscle as it passes behind it The point of contact is the location for so called ganglionic cysts

The internal lateral ligament is a wide fan shaped fibrous band extending from the external condyle of the femur to the outer tuberosity of the tibia It consists of a long anterior and a short posterior portion The broad posterior portion is distinctly fixed to the internal semilunar cartilage This fixation is a definite disadvantage since in a sudden twisting of the joint the cartilage cannot get out of the way of the articulation and becomes jammed and torn The internal semilunar cartilage is therefore more commonly injured than is the external the percentage being about 12 to 1 Sir Robert Jones gives the percentage as 7 to 1 A strain upon the internal lateral ligament is much more severe when it is associated with a twisting movement of the joint

In order to bring about lateral movement of the knee joint we found it necessary in our experiments to sever not only the internal lateral ligament but also the crucial ligaments

Figure 2 shows the relation of the internal lateral ligament to the internal semilunar cartilage Note the portion that is free and retracted by the instrument The illustration also shows the transverse ligament which binds the cornua of the semilunar cartilages The fixation of the anterior cornu of the external semilunar to the tibial articulation is quite firm

The crucial ligaments are situated in the center of the articulation and have a very important function The anterior crucial ligament prevents the tibia from slipping forward upon the femur while the posterior crucial ligament prevents the tibia from sliding backward upon the femur The

crucial ligaments assist the lateral ligament in maintaining stability of the joint when it is in the extended position. When an individual has received an injury to the knee joint and the examiner is able to displace the tibia forward or backward upon the femur the knee being in the extended position the finding suggests a rupture of the crucial ligaments.

CASE J F female aged 41 the Mch 1 Recd Ho pital with a tal disl t of both hips d k Bv th clo d m th d the hps w e s c c f lly l d b t h k w e t Th w a b l t n f t t b a k w d p th f m a l c dyle A pen p at o w a w a t m p t d a d n arth of my per f m d Tl p t n ru llg m tw hot n d d d o p e r m t d t o of the t b a w h e t h t n o r u c l l g a m e t w a r y m h e d n l g t h i t l a y t e t f the t l a t n k t d u s b a d Th p o t n cru llg m tw cut th s p r m t t g t h t b to m f w d t h a t o r u l w a d d a d b t h l f h t d the n d s w e b u g h t t g the a d t h k e w a p l a d i t e n s n

This case demonstrated the inability of sliding the tibia forward on the femur because of the short posterior crucial and the retention of the tibia in its normal relation to the articular surface of the femur by shortening the anterior crucial ligament. It must be noted however that when luxation of the tibia backward on the femur occurs and remains so for a period of time the posterior capsule contracts making induction impossible. This also takes place when the knee remains in flexion contraction for a long time and extension becomes limited.

CASE S H female aged 63 sof g w s b ht t m b l d n t d t d a j r y t h e l f t k j i t Sh tat d t h t t t h e d k e v a s t r u c k f b l y w h o t h o p t n t h a w a s t h w n a n t h O m t o t h e k j o t w s o d w l l a d r y p f l t h w a s c o n d e r b l f d p e t t h w c d b l l t l m o b i l i t y d t h e t b l d a l b d p l d f r w d o t h e f m A t g m l d f r a t r f t h r t c u t r s f e f t h t b a t d g t h g h t b a l s p A d g i s f t f t h r u l l g m e t t g t h e w i t h a r u p t u f t h e t m l l a t r a l l g m t w n i r m e d

The synovial membrane of the joint is an endothelial serous lining which surrounds all of the structures of the joint adapting itself to prominence and depressions. The joint is divided into two main compartments the small posterior and the larger anterior. The synovial membrane extends for about 1/4 inches above the superior border of the patella. The synovial sac is filled with an inflammatory exudate all of the normal superficial outlines of the joint are obliterated. This is especially true of the suprapatellar surface

as well as the lateral surfaces of the joint above the patella.

In the infrapatellar space a fold or pad can be seen stretching across the joint and filling the space between tibial and femoral articulation. This fat pad is triangular in outline with the base directed upward and forward its apex is directed to the center of the joint and it is held in position by a well defined ligament known as the ligamentum mucosum. This extends from the apex upward and backward to the intercondylar notch in front of and blending with the anterior crucial ligament. Laterally the pad blends with the capsule and in addition is supported or suspended by 2 fibro elastic bands called the alar ligaments. These bands are found on its lateral peripheral borders. They extend upward and adapt themselves to the outer and under borders of the patella blending with the aponeurosis of the quadriceps extensor tendon. The outer alar ligament is very indistinct and often missing and although frequently it can be definitely made out on the outer under peripheral border of the patella its lower extremity becomes indistinct and blends with the pad fat. The inner alar ligament is constantly present and often forms a double fold especially in males and in well developed knee joints but in atrophic knees it participates in the atrophy of the other structures. The inner alar ligament as a rule is wider than the external and can be traced through the fat pad sending fibers which blend with it and descend to become incorporated or inserted with the coronary and transverse ligament into the anterior cornu of the internal semilunar cartilage. When traction is produced upon the internal alar ligament the pad can be elevated and the cornu of the semilunar cartilage can in turn be displaced from its position.

Figure 3 shows the infrapatellar fat pad. The band of fibrous tissue which holds the pad to the intercondylar notch should be noted. This is the already mentioned ligamentum mucosum. The illustration also shows the folds which extend from the pad to the outer borders of the patella. These are the alar ligaments. The inner fold is very distinct and in this case is double. The fibrous bands from the internal alar ligament extend downward to become incorporated with the coronary ligament and attached to the anterior cornu of the internal semilunar cartilage.

I hold the opinion of Pozet that the internal alar ligament plays a definite role in the production of displacements and rupture of the internal semilunar cartilage. When the knee joint is opened so that the internal cartilage becomes visible and motion of the joint is carried out either

in flexion or extension the cartilage cannot be misplaced from its position. However when forcible traction is exercised upon the patella the anterior cornu of the internal cartilage can be brought forward and away from its tibial position.

We can therefore visualize the position of the knee joint which favors injury to this cartilage namely slight flexion of the knee abduction of the foot and inward rotation of the femur. Should an emergency require a sudden rectification of the joint to its normal position the following events should occur sudden contraction of the quadriceps tendon which pulls the patella with a violent jerk. The anterior cornu of the internal cartilage would then be pulled away from the region of safety by means of the internal alar ligament. In addition the knee in trying to assume the erect position would have to pass through a rotary or as it is often referred to a screw home movement accompanied by sudden extension. If the cartilage does not get out of the way of the articulation it becomes pinched and torn. Pozet has traced distinct bundles from the fibrous folds already described to the anterior ends of the semilunar cartilages and believes that they serve to pull the semilunar cartilage forward and upward with the contraction of the quadriceps. Tenny could not trace such bundles but found these folds spreading out generally into the fibrous framework of the infrapatellar pad. He believes that their function is to pull this pad forward and upward out of harm's way during extension. This statement may be correct but it does not detract from the idea that is here presented namely the effect of the alar ligament upon the internal semilunar cartilage. Tenny asserts that these fibrous bands do not appear in joints hardened in formalin. It must however be remembered that Tenny did his work on cadavers so that these delicate structures may have become distorted. Hoffa states that the lower part of the fat pad joins the meniscus and is also connected to the periosteum of the front part of the tibia. The connection to the periosteum alludes to the coronary ligament.

The infrapatellar fat pad gives off numerous small tail like padules or fringes which are intended as wipers of the articulating surfaces—so called lubricants. When by inflammatory hyperplasia these tail like padules become elongated the alar ligaments cannot pull the fat pad up out of the crushing grinding articulation and thus they often become pinched and cause the characteristic symptoms of pain and locking. It must be remembered that derangements of the semilunar cartilages may be associated with other pathology. One therefore cannot emphasize too

strongly the importance of a complete exploration of the knee when the clinical history and physical findings are not clearly definite. In several of our cases of ruptured semilunar cartilage a small portion of the synovial membrane was removed. This tissue in every case showed a chronic inflammatory change. It must therefore be borne in mind that repeated locking of the joint is not only associated with a mechanical disturbance which disappears with the reduction of the cartilage but often results in a chronic synovial inflammatory change which may persist even when the cartilage is removed.

CASE 3. A male patient 55 years of age came to the hospital stating that about 10 years before he had stumbled and sprained his knee joint. He felt quite sure that the joint locked at that time. He has had numerous lockings since then. A roentgenogram was taken of the knee and it disclosed numerous osteocartilaginous bodies. The joint was operated on. The anterior portion of the internal semilunar cartilage was practically gone but there was a chronic synovitis with numerous fibrous bands stretching across the joint and a number of osteocartilaginous bodies.

MECHANISM OF RUPTURE OF THE INTERNAL LATERAL LIGAMENT AND RUPTURE OF THE SEMILUNAR CARTILAGE

The knee is a modified hinge joint with only a slight degree of sliding and rotation which takes place only in the final act of extension. The most insecure position of the joint is midway between flexion and extension and is referred to by Morrison as the danger zone. When the foot is firmly fixed upon the ground the knee being slightly flexed a sudden rotation of the femur inward with an attempted extension of the knee may cause a rupture of the internal cartilage. This can best be illustrated by citing some illustrative cases.

CASE 4. A dancer during a performance when he was to catch his partner as she descended from mid air suddenly felt that his right foot was glued to the floor as though he had stepped on some gum. He could not take the sliding step to break the impact of the heavy weight. His knee bent under him and he experienced a sharp stabbing pain. The knee joint became markedly swollen and was locked in a flexed position. An X ray suggested a torn internal lateral ligament and a displacement of the cartilage. Reduction was accomplished by reposition.

CASE 5. A pair standing upon an insecure ladder swayed back and while his foot was caught in a rung. In trying to regain his equilibrium he twisted his left knee joint and experienced a severe pain on the inner side of the knee. Effusion followed the knee became locked and the locking recurred on several occasions. The X ray report was negative. When the knee joint was opened the cartilage was found loosened and torn at its fibrocartilaginous junction.

CASE 6. A girl age 5 years stated that while she was riding in a crowded car and hanging on to a strap the car came to a sudden stop and her body swayed forward while

he n ht foot ma ned f mly fix d to th floo She ex
perce ced p o th n r d of the right kn j it She
walked hom but thep in he kn cnt ned Wh n h
c m e f e m i a t n th e w a m e f u n n h k e
a l m t t n t m t o n and p n o n th n s i d f
th k e t e l th p t l l a Th t e r n l m l r t l g
v a f o d t t h d

CASE The p t n p s e t d h m l f t M h a l R s
H o p t l th t f l l o v i h t o r y S e l d a y p
l y w h e h l l f m a g o a d t h w g t o a
c n d l l e d t h e t s t e d h r g h t k n e n d f e l t
th d e p a o t h e s d e f t h k c u
the k t o g i a v f o m d e h u m H e t p p d w k
d l m p d h m W h t h k w a m d i t w
f u d t l l o c k d m f i n Th w d t c t
l m t t t o x t d m p d t d t o t h n
s i d e f t h k n m m d i t l y b e l d n f n t o f the
p t l l \ v m t r l d o h n e n t h
j n t d d f d p l a d d t r n a t l g w
m d d i m d t p r t Th a t l a t n
a t t f b r a t l g j u n c t o

In addition to the anatomical factors con-
tributing to derangements of the semilunar carti-
lage certain physiological reasons may perhaps
explain their formation. Thus the normal rotation
of the body in right handed individuals is to ward
the left. The body pivots upon the left knee in
the act of rotation. The foot is arrested by the
ground while the femur rotates inward upon the
tibia. This is illustrated in the act of bowling
golfing and shovelling and may account for the
fact that the condition occurs more commonly in
the right knee joint.

DIAGNOSIS

The diagnosis of lateral ligament rupture and of
fracture and displacement of the semilunar carti-
lages depends almost entirely upon the clinical
history. These accidents occur as a rule in young
active adults and more frequently in men than in
women. The sequence of events in the production
of the accident must be carefully investigated. A
twist and a sudden attempt at extension of the
knee is the characteristic method of production of
the derangements.

Because roentgenograms do not disclose der-
rangements of the soft tissues attempts have been
made to introduce gaseous substances into the
joint for the purpose of bringing out the soft
tissue structure. Kleinberg reported a series of
cases in which the knees were injected with oxygen.
We have inflated the knee joint with carbon
dioxide for the same purpose. As it is an end-
product of metabolism it is felt that its effect upon
the tissues would not be as irritating as oxygen or
nitrogen and also that its absorption would be
more rapid. Fifty knees were inflated and in each
instance the practice was of great aid. When the
clinical history is clear and one is certain about
the findings inflation should not be employed

but when one is in doubt as to the pathology in-
flation is of great help.

Technique of inflation. The knee is prepared
as for an arthrotomy. The knee is roentgeno-
graphed in the anterior posterior and lateral po-
sition. It is then flexed to an angle of about 90
degrees and a needle inserted on the inner side
below the patella. The carbon dioxide is intro-
duced until a soft crepitus can be felt over the
joint. About 30 to 40 cubic centimeters of gas is
sufficient. One must be sure that the needle
enters the joint before the gas is permitted to
flow otherwise the gas enters the soft periar-
ticular tissues. There is a momentary sensation of dis-
tention of the joint but no extreme pain nor dis-
comfort. Most patients upon whom inflation of
the knee was performed were from the out patient
department and were permitted to go home soon
after the inflation.

The spaces to be studied are the suprapatellar
pouch the infrapatellar space and the posterior
compartment. The suprapatellar pouch assumes
the appearance of an inverted gall bladder. The
infrapatellar space is almost triangular in outline
while the posterior space is crescentic. In a normal
knee joint all the spaces are clear and well defined
(Fig. 5). Changes in the infrapatellar space are
indicative of hypertrophic villus synovitis chronic
synovitis changes in the pad of fat and displace-
ments and tears of the semilunar cartilages (Fig. 6).

The diagnostic signs and symptoms of a
torn cartilage in order of their importance are
pain locking limitation to full extension and
effusion.

As a result of a mild torsion producing a tear
and displacement of the internal semilunar carti-
lage the knee becomes locked this locking is
accompanied by a sickening pain which persists
for some time and extension of the joint is more
or less difficult. The pain as a rule is referred to
the inner side of the knee immediately below and
to the side of the patella. When numerous lock-
ing occur the pain is less intense. When reposi-
tion is accomplished the pain at once subsides
and the knee assumes a normal extension.

Limitation to full extension is the next important
symptom after pain. Normally the knee joint can
be extended to an angle approximately 180 de-
grees. In derangements due to semilunar carti-
lae displacement the knee is bent and it is
difficult and painful to straighten it out. When
reposition of the cartilage is accomplished the
knee can be straightened to almost normal
extension.

Pain is a constant symptom and is described as
sharp lancinating stabbing or boring in char-

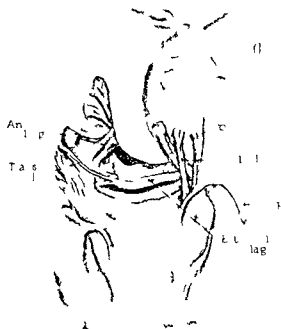


Fig. 1 External lateral ligament and relation to popliteus muscle

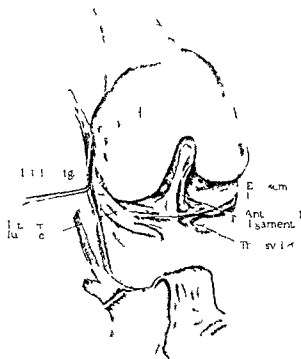


Fig. 2 Relation of internal lateral ligament to internal semilunar cartilage

acter. The pain is referred to the inner side of the knee below and to the inner side of the patella. The pain is often severe enough to keep the patient awake and is most intense when motion of the joint is attempted. Tenderness on pressure is marked at the site of the cartilage and over the internal lateral ligament. Pain is also experienced when an attempt is made to stretch or mobilize the knee joint. When the cartilage is replaced the acute pain subsides but there may remain a dull ache for a short time and pain may be experienced when the joint is moved.

Effusion is variable in quantity. As a rule there is very little fluid in the joint but the knee may be increased in size. When the joint is locked in flexion and is permitted to remain in that condition for some time the effusion is increased in amount. Repeated lockings may not cause further effusion.

Aspiration of the joint is never indicated. The effusion is a result of irritations and trauma and is an exudative process. When effusion is present inflation of the joint for diagnostic purposes should be postponed until it has cleared up.

CASE 8. A 16-year-old girl, aged 3 years, entered McChesney Hospital with the following history: "About 4 years ago she had slipped and twisted her knee while dancing. The knee was quite painful and she was unable to

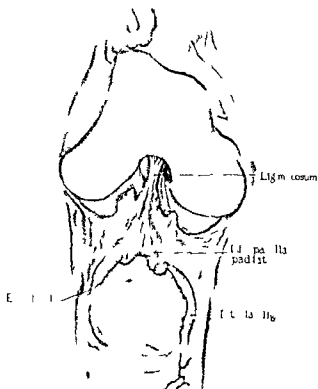


Fig. 3 The infapatellar fat pad



F 4

F 5

F 6

I g 4 Ant r p s t o of a inf ted k e j t
I flat of th kn j t obt ed by c b n d v de a
t t d th t t Not the fll b th ca t l g e
pl n l l th lat r l r e f th kn j o t The
t t h m t f t l te al late al game t t the t r n l
m l a c r t l a g i p l y b l The t r n l m
l u r a t l n u t t h d Th g a d i t d th
up a p t l l a p h Th m l k e
J Sh w f l t f m l k j n t b y m a
f b o d d V t the foll w g the up p tell
pouch s m th h p f g l l b l d d Th wall a
mooth d l Th fr pat l l p m o i s
t r i l a n u t h n d th p t r i c m p t m n t of th
k e j n t a m s m l n t l m Wh path lo y

t ght t O th n d d y the k e w a s w l l d
n t f l e H t p p l t i n d d d th
p t t r m n d b d f b o t e e k Th e l l g
t l d d the p g r d l l y d p p e d Sh e
m d h l n f t d A b u t y e g o s h
j d h g h t k n i h d c c of y m p
t m m l t th h p n e d f t h f t j r y
S h th m t t h k f i l Th d b w m d
f a t a d d p l d t l m l n t l
Th k w p n d t h g h J a d d h
t r h l f f th c t l g l y l k f f b d y
Th m d d th k j u t l o d Th k
t n d t m l t t a d th p t r n t f f m
t u b l t l t h p t t i m e

S r a l k s h l n a f Wh h
t t e m p t f t h l p p d d f l l t th floor t a s t g
h k u d h She do t e m e m b h t h e
f t t h d the g u d o t Sh t h u n k t h t s h f l l n
h f l l k Th t m p n t h s d
f t h k S l t h l l h o o p p d n d th p
h t p the f m l p g
On Octob r j f m d th t m y w s p f m d
u d x th a Th h l n t f t h j n t e
f u l l y d t h u h l p t e d Th p r a p t l l p a c
h y p r m c d t d n d p t d g l a
j l d p p c Th f a t t e e l t e d o t d
n d th k e d Th f t p d n l a g e d n p t p t d
th g n r a l p t h l g l p c t r of h r o y n o t

p e t th k e j o t the e p c a e d t t d m
c s d i z e d h o w th p e s c e f i r g n m t e l
t h r a t l g u s f t t r u c t r e a F o u 6
F 6 Late l e f f l t e d k e e j n t h w g a
p a p a t e l l a p u h g l a r i t l n e d m h t
d m h d s i z e The f p t l l a p c i m l e s
l i l k p p a a e l t t h e a t e t u l f i c e of
the t b i c p n d n t t h p o t f t h n t e r a l
c t l a s h d o w p t T h s e a l d s p l c e d
c a t l a w h h w o f i r m e d a t p r a t A o c i t d
t h t h e d p l a d t l g e a h o n c y l c h g e
p t n t h k e j t Th u s t f t h d c s e
s i z e f t h i f r p a t l l a p a e n d p b a b y d t o
h y p t p h e d p a d of f a t

Th e m a t n l m l u a c t l a s of th
b u k t h d l t y p e f d p l a m n t T h e a t e p t
a g e d t h m p t o n f t h c a t l g p
p d m o t h h d a d d p l c d t t e t t f
t h e j t T h e a r t l a g w a s r m e d i t t y t
t h w i t h t h k e d y l t s d p t o
o f t h f a t p d Th p t e g n d f m t t h j a t
d f f t h h p e t t h t e t h d v w l k u t
n u t h s

This case illustrates the importance of carefully inspecting the interior of the joint. If a careful examination of the internal cartilage had been made at the time of the first operation there would have been no recurrence of the condition. However it was thought at the time of the first operation that the anterior free margin had been torn off and that the remaining portion of the cartilage was in place.

C s o A y t h l t c m 6 j of t a t
g t h b o u t y e d h l t h i t a r t p t
t m h h h a d t k e l a f l o w h m d
h l y h n h t k d t h e n g t p h a v l l
l l f t a d d p h n h t k n d c l l n t
t a h t n t h j t t t m l e x t e d e d p u Th

knee hurt him considerably and for 10 days he limped. After that time he had occasional pain in the knee localized on the inner side of the joint below the patella. During the attacks of pain his knee locked and he could hear a click in the joint.

On examination the knee appeared normal—no swelling or effusion. It could be extended and flexed to almost the normal range. On the inner side of the knee joint the examiner's thumb being firmly held over the region of the internal cartilage a click such as one often finds over a slipping tendon could be felt. There was some tenderness. X-ray examination was negative.

Diagnosis was made of a displaced and ruptured internal semilunar cartilage and on September 19 the knee joint was operated on. The method employed in this case was the same as that carried out in all our cases and will be described in detail.

OPERATION

The extremity is shaved above and below the knee joint special care being taken to remove all hair over the knee since long hair may be responsible for infection following the operation. The knee is prepared the night before by a thorough washing—ether and alcohol and a coat of iodine. This procedure is repeated at the time of the operation. One must always bear in mind that because infections do not occur as commonly after operation as in times past one cannot become lax in the preparation of patients. I always prepare the knee joint myself in order to be absolutely sure of the asepsis. The knee is bent to an angle of 45 degrees over the foot of the table. An elliptical incision is made $\frac{1}{2}$ inch to the inner side of the patella beginning about $1\frac{1}{2}$ inches above and carried about $1\frac{1}{2}$ inches below the patella. All bleeding points are ligated to prevent any possibility of hæmorrhage under the skin. Very fine catgut is used and the ends cut very short. The parts are covered with wet lap sponges and a second knife used to cut the subcutaneous tissues and the fascia down to the capsule of the joint. The capsule appears like a tense loose structure. This is incised with a pair of scissors and the edges are caught as in the case of the peritoneum in abdominal section. The edges are retracted and the incision is completed above and below to expose the joint. The first visible structure is the inner condyle of the femur. Two small ribbon retractors are introduced into the joint and the joint is thoroughly inspected. The cartilage can now be easily seen resting on the articular surface of the tibia. The anterior crucial ligament appears as a firm fibrous band. The anterior cornu of the cartilage is gently grasped with a tissue forceps and inspected for pathology. In this particular instance the cartilage was long and twisted and displaced to the center of the joint. It was a typical bucket handle variety. The

cartilage was severed at its proximal portion close to the tibial attachment and pulled forward and severed from the capsule by means of a curved dissecting scissors at its posterior attachment.

The fat pad can be examined for inflammatory changes and elongations of fat triges. In each instance we found a change in the fat pad characterized by inflammatory hyperplasia. Any oozing that takes place can be checked by a small gauze pack which is inserted into the joint and held there for a few moments. It is not advisable to compress any small bleeding points nor is it advisable to place ligatures into the joint. If ligatures are to be used they should be of fine catgut and the ends cut very short. The capsule is now sutured with a fine catgut stitch the subcutaneous tissue with No. 1 chromic catgut. The skin is closed with a running silk suture. No drains should ever be inserted into the knee. The limb is placed in extension in a posterior molded plaster splint. Passive exercises are to be employed as soon as the patient can bear them. On the tenth day the patient is encouraged to use the limb and permitted to step with the aid of crutches.

As one gains experience in this type of surgery he approaches the knee joint without apprehension. The employment of the Lane technique cannot be emphasized too strongly in connection with knee joint surgery and it must always be remembered that an infection following the removal of a semilunar cartilage can leave the patient with a stiff knee. When the diagnosis is uncertain a median arthrotomy should be performed. The knee joint is approached through a split patella. In this way the entire knee joint may be inspected.

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At bronchoscopic examination the left wall of the trachea was found to be invaded by a large mass which reduced the lumen to about one fourth its normal size. The mass began about 2.5 centimeter below the larynx and extended almost to the tracheal bifurcation. It was difficult however to determine with accuracy the lower limits of the process. The tumor was granular and firm and moderate bleeding followed the removal of a section for microscopic examination.

Grossly the lesion resembled a malignant tumor of the trachea but the extent of involvement was greater than had been previously noted in tracheal carcinoma (Fig. 1). The microscopic examination of the tissue disclosed its tuberculous nature (Fig. 2).

Following bronchoscopic examination the patient was able to breathe with greater comfort because on introducing the bronchoscope to the bifurcation of the trachea superficial ulcerating tissue was removed and the lumen of the trachea was thereby enlarged. A course of treatment by

deep roentgen ray was given and the patient instructed to continue with the usual antituberculous regimen.

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FASCIAL GRAFT FOR DISLOCATION OF ACROMIOCLAVICULAR JOINT

By STERLING BUNNELL, M.D., SAN FRANCISCO, CALIFORNIA

IN complete upward dislocation of the outer end of the clavicle not only the acromioclavicular ligaments but also the conoid and trapezoid ligaments that should hold the clavicle down to the coracoid process are ruptured. This allows the outer end of the clavicle to ride upward in the shoulder when the patient lifts, produces considerable deformity, causes weakness in the lifting power of the arm and difficulty in some shoulder movements.

At operation not only should the acromion process and the clavicle be fastened together but the clavicle should also be held down to the coracoid process. Ankylosis of the joint will not permit movement. Wire if used in tying the parts together will wear and break as in any

movable part. Tying of the clavicle to the coracoid process with fish line has been recommended also but such a foreign body will wear out in a short time.

Fascia is the ideal material as it is a natural binding agent; it hypertrophies under conditions of normal tension, allows normal motion in joint and lives as long as patient. A quick, easy, efficient method of using fascia has been devised.

Through an L shaped incision with its apex on the inner anterolateral to the joint the upper surfaces of the acromion and clavicle are exposed and also the coracoid process at its ligaments. Three holes 5 millimeters in diameter are drilled. The first hole penetrates the tip of the acromion slightly in front of the center of the joint, the



Fig. 1

Fig. 1. Showing the nat. my of the conoid and trapezoid ligaments, the position of the 3 holes in the bones and the fascial graft (indicated by rubber tube) in place but not yet drawn up.



Fig. 2

Fig. 2. Showing fascial graft (indicated by rubber tube) in place and sutured as seen from the front.



Fig. 3

Fig. 3. Posterior view of the specimen shown in Fig. 2.



Fig. 4. d. s. p. (t. l. f.) d. f. o. v. f. a. m. e. p. m.
h. w. g. t. f. o. m. t. f. j. t. f. l.



Fig. 6. S. l. p. t. t. w. m. t. l. p. t.
p. f. d. m. t. h. p. o. l. v. l. t. h. h. h. l. f. t. g.
h. y. l. l. l. f. f. b. d. t. t. d. h. t. w.
d. d. d. t. h. f. c. t. o. m. l. t. o. m. v. p.

second penetrate the outer end of the clavicle slightly behind the center of the joint and the third penetrates the clavicle at the outer end of the trapezoid ligament.

The upper surfaces of the bones are then denuded of periosteum in a line with the holes and at the posterior border of the clavicle so that bony contact with the fascial graft will be obtained.

A strong piece of catgut on a curved needle is then threaded down hole 1 up hole 2 then passed back of the clavicle and with a Deschamp carrier is passed around under the coracoid process down

its inner side up its outer side and finally up through hole 3.

A strip of fascia lata 10 inches long and 1 centimeter wide is then taken. One end is cut in a long taper caught in a slip knot in the middle of the piece of catgut and drawn through each hole in turn along the course of the catgut.

A piece of No. 3 chromic catgut is passed through holes 1 and 2 tied tightly in order to hold the joint together and prevent strain on the fascial graft until the latter has grown to itself and to the bone.

The two ends of the fascia are then by fastening a hemostat to each drawn up tightly crossed over toward each other and held there while they are whipped together with a running stitch of No. 3 Turner's patent ligature silk previously dipped in bichloride solution. The third ply of fascia is also caught in the stitch. The end pointing inward is cut off and the other end is laid across the joint to reinforce the capsule further and is held there by a stay suture. The wound is closed and the arm placed in a sling for weeks.

ADVANTAGES

The one strip of strong fascia reproduces anatomically the conoid and trapezoid ligaments as the two fascial strips correspond to the two borders of these ligaments. It also reconstructs the superior and inferior ligaments of the acromioclavicular joint and reinforces the superior ligament with an extra plication. The fascial plications fuse to each other and grow to the bones by intimate bony contact.

Practically the method gives a perfect result as shown in Figure 6. Although the patient is lifting a heavy anvil no difference can be detected in the contour of the joints on the two sides.

LIGATURE OF THE ANGULAR VEIN AS A PREVENTIVE MEASURE IN FACIAL CARBUNCLE

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CARBUNCLE of the face has a sinister reputation and the upper lip is the most common site of this dreaded lesion. A complication which quite frequently heralds the oncoming of a fatal pyæmia is thrombophlebitis of the cavernous sinus.

In a series of 15 consecutive cases of thrombophlebitis of the cavernous sinus I found that 4 were due to a furuncle or carbuncle of the upper lip and that 3 more originated in an infected gnath bite of the nose. Thus in nearly half the cases of the series referred to thrombophlebitis of the cavernous sinus had its origin in a comparatively simple lesion in a circumscribed area. While reference to Eagleston's monumental monograph on cavernous sinus thrombophlebitis convinces me that this percentage is abnormally high it is clear that infections of the upper lip and the skin of the nose are the cause of a formidable proportion of the cases of thrombophlebitis of the cavernous sinus met with in general surgical practice.

From an anatomical consideration infection may pass from the upper lip and the nasal integument to the cavernous sinus by one of the two venous paths. That the more circuitous route through the pterygoid plexus is not often taken is shown by a study of necropsies of this condition in the records of the London Hospital Pathological Institute.¹ In 4 cases the path of the pyæmia could be traced satisfactorily along the angular vein.

It is therefore reasonable to assume that the angular vein forming as it does a communicating link between the venous radicles of the upper lip and the ophthalmic plexus constitutes a main channel by which infection passes into the venous system.

To forestall the spread of infection by this route ligation of the angular veins must be a sound proposition, but the risk of the inhalation of a general anæsthetic in a febrile patient whose buccal cavity is swarming with virulent organisms has deterred surgical enterprise in this direction.

Ligature of the angular veins under local anæsthesia is a measure which is entirely free from

danger and one which can only do good. If necessary ligature may be done on both angular veins.

It is desirable to have some guide as to the most opportune moment for this intervention for it is quite obvious that the resistance of the patient is sometimes sufficient to keep the infection within bounds. On the other hand the necessity for timely interference must always be before us. On the whole it is better to err on the side of activity.

A sign which foretells impending danger is spreading œdema from the lip to the inner canthus and this is usually found in the presence of suffusion of the eyelids. As far as my own observations have gone the premonition is invariably unilateral. If in addition to this sign there is considerable elevation of temperature the call for action is imperative.



Fig. 1. Ligature of the angular vein.



A



B



C

Th m th l t C l l f th pp l p A T l h ft l at f l B S m k l t C S m

TECHNIQUE

If there is any suggestion of delirium it is advisable to administer a hypnotic 10 minutes before operation. Castor oil should be introduced into the eye and a damp gauze covering applied over the eyes to prevent iodine running into the conjunctival sac. The lip is covered with gauze wrung out in perchloride solution. Dry gauze becomes easily displaced. The angle made by the junction of the nose with the cheek is the surface marking for the vein. After novocain has been infiltrated an incision is made commencing a little below the inner canthus and passing downward and a very slightly outward for about 1 inch.

There is always a lot of troublesome oozing which can be quelled by packing with gauze soaked in adrenalin. After more novocain has been injected dissection in the wound will reveal the levator labii superioris alaque nasi. The fibers of the muscle are teased apart and the angular vein will be found either in or beneath this muscle. It is divided between ligature. Skin sutures and a collodion dressing complete the operation.

C E A ma s f c h d a c b l
h pp l p Sh h d h d t f d s It l
l m p l wh h h h d q d Th t t t h d o
d b l d l n m d a t m p t f d g The
ht y m p l t b l d b ff f th v l d



A

I l ft C l l f th pp l p Th m b o f t l



B

f th 4 Th mb f t l C b d
f th pp l p Th ll t t t k f m th
th f l S g cl t t S g y

Under general anaesthesia the right angular vein was ligatured. The carbuncle was incised through the red margin of the lip. Local applications of gauze soaked in hot magnesium sulphate solution were applied. After a slight improvement for 48 hours on the fifth day the patient succumbed to a terminal pneumonia complicating general septicemia.

Cysr 2. A girl aged 16 complained of a large carbuncle which had been 9 days previous as a pimple on the middle of the upper lip and which had elapsed into a carbuncle of both upper and lower lip. It had become much worse 48 hours before admission. Examination showed an oedema preadun toward the right eye with great suffusion of the e. elid. Her temperature was 103 to 104 legrees, as acute l with mild hirmum.

Ligation of the left angular vein was made and intra-venous mercurochrome was administered followed by local treatment of the carbuncle with hot magnesium sulphate fomentations. A rapid improvement resulted and the patient was discharged 4 days later.

Case 3. A man 60 years of age was admitted with a carbuncle of the upper lip of 3 day history. His temperature was 38.5 degrees. There was oedema spreading to the right eye. The angular vein was ligated and whole blood was injected around the periphery of the carbuncle. Hot gauze soaked in hot magnesium sulphate solution was applied locally. A blood culture grew a staphylococcus. Intravenous mercurochrome was administered on the second day. Seventeen days later the patient had recovered sufficiently to return home.

Case 1 occurred 4 years ago. I now believe a general anesthetic is absolutely contraindicated in these cases. As regards the local treatment of a carbuncle, I have given up incision and simply

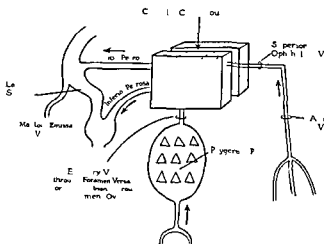


FIG. 5 The cavernous sinus and its connections (diagrammatic). Taken from the author's article in the *Clinical Journal*.

inject the patient's own blood into the tissues around the carbuncle and apply hot moist dressings. This combined with general treatment has given satisfactory results in carbuncles in all situations.

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A SHORTER TECHNIQUE FOR THE COFFEY OPERATION IN CANCER OF THE RECTUM¹

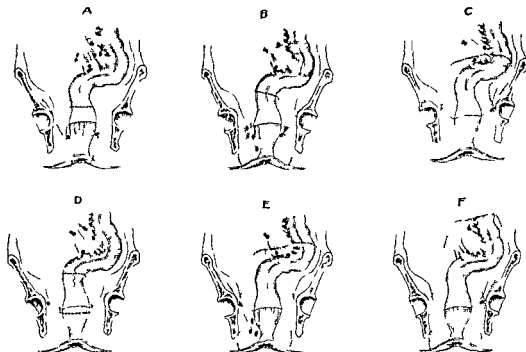
B DUDLEY SMITH MD FACS S N FRANCISCO CALIFORNIA

F m h D p m t f S g y U r s t y f C I I

FOR many years the principles of operative procedure in cancer have been definitely standardized but many surgeons seem to disregard these fundamental principles in operating for cancer of the rectum. Unless the operation removes the lymphatics in the three zones of spread as so well described and illustrated by W L Miles (1) in the *British Medical Journal* it is not a complete operation and the percentage

of 5 year cures will not be as high as it should be. This removal can be done only by a radical abdominoperineal operation (Fig 1)

The one stage abdominoperineal operation of Miles unfortunately carries with it a primary operative mortality of 25 per cent or more even in his skillful hands. This high immediate operative mortality lends strength to the argument for less radical procedures



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of 5 year cures will not be as high as it should be. This removal can be done only by a radical abdominoperineal operation (Fig 1). The one stage abdominoperineal operation of Miles unfortunately carries with it a primary operative mortality of 25 per cent or more even in his skillful hands. This high immediate operative mortality lends strength to the argument for less radical procedures.

The Coffey operation is a modification of the Miles operation. It is a one stage operation which removes the tumor and the lymphatics in the three zones of spread. The operation is performed through a single incision and the creation of a colostomy. The Coffey operation is a modification of the Miles operation.

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Fortunately however Robert C Coffey has devised an abdominoperineal operation which is done in two stages has in his hands an operative mortality of about 5 per cent. No operation can be more complete and thorough. Coffey in 1924 () presented a clear and well illustrated description of his operation which includes the following steps

- 1 Long right rectus incision
Ligation of the superior hæmorrhoidal artery and vein
- 3 Mobilization of the sigmoid and rectum
- 4 Clamping and cutting of sigmoid drawing proximal segment through stab wound in left rectus for colostomy
- 5 Pushing rectal tube up through sigmoid to clamp on distal segment placing purse string suture around the gut below clamp removing clamp end inverted fixing end of rectal tube to inverted end of gut trimming mesenteric fat well down to the bottom of the pelvis inverting sigmoid and rectum and drawing them out through the anus
- 6 Closure of raw surfaces and formation in the male of an extra abdominal peritoneal tube for drainage through the lower angle of the abdominal incision. In the female the peritoneum and abdomen are closed in the usual way and drainage is secured through a hole in the posterior vaginal fornix

In cases in which the cancer has caused sufficient obstruction to prevent inversion of the sigmoid and rectum Coffey double clamps the rectum either above or below the cancer cuts between the clamps with the cautery and removes the sigmoid and the portion of the rectum above the lower clamp leaving the clamp on the stump of the rectum the handles protruding in the male from the lower angle of the abdominal incision and in the female from the vulva. This is a long operation Coffey says. There is much sewing to be done in this operation which requires a great deal of time. In short the radical operation for cancer of the rectum is one of the largest in surgery.

It has been my purpose to shorten the operation as much as may be without abridging its thoroughness. We have not found that better results follow when the sigmoid is inverted than when the gut is clamped off and the tissues above removed. Moreover if lymphatic extension is present in the mesentery or the retrorectal fat the trimming off of the fat well down into the pelvis is not without danger of transplanting cancer cells. Accordingly the clamp without

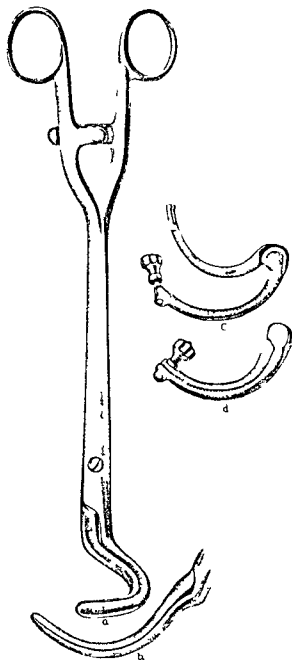


FIG. 2. Author's clamps. *a* Long clamp with jaws at most at right angles to the handles. *b* Shows the curve of the jaws of clamp *a* corresponding to the curve of clamp *c*. *d* Bite 3 inches long. *e* Clamp without handles open. *d* Clamp closed. Bite 3 inches long.

handles (Fig. *c* *d*) was devised. The technique of Coffey as already outlined is followed up to and including the fourth step. The fifth step is eliminated and in its stead the clamp is placed around the rectum either above or below the growth depending upon its location, closed tightly by means of a long handled strong jawed forceps and the clamp securely fastened by the thumb screw. The rectum is clamped just above with a right angled forceps with curved jaws.

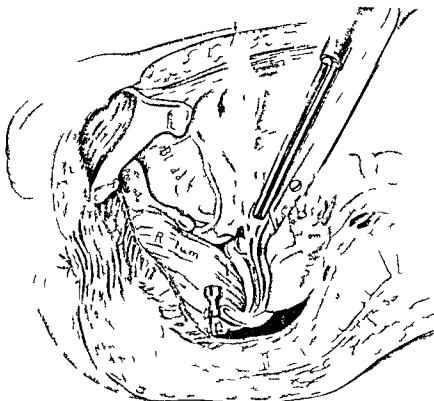


Fig 3. The sigmoid colon is mobilized and the rectum is removed. The stump of the rectum is held by a clamp and is thoroughly sterilized with the cautery. A pack of gauze is placed over the rectal stump and around the clamp completely covering it so as to protect the adjacent tissues from pressure. Over this is placed a piece of rubber dam and the peritoneum sutured over it (Fig 4). The abdomen is closed in the usual manner leaving the clamp in the pelvis until the second stage of the operation is performed 10 days later.

corresponding to the curve of the other clamp (Fig 2 a b). The gut is then severed with the cautery between the clamps (Fig 3) the mobilized rectum and sigmoid removed and the stump of the rectum where it is held by the clamp is thoroughly sterilized with the cautery. A pack of gauze is placed over the rectal stump and around the clamp completely covering it so as to protect the adjacent tissues from pressure. Over this is placed a piece of rubber dam and the peritoneum sutured over it (Fig 4). The abdomen is closed in the usual manner leaving the clamp in the pelvis until the second stage of the operation is performed 10 days later.

We secure drainage by making a small incision alongside the coccyx through which 2 rubber tubes are passed upward into the cavity back of the mobilized rectum (Fig 4).

Objection may be offered to drainage through a posterior stab wound on the ground that it is uncomfortable for the patient but we believe dependent drainage to be advantageous and we

have not found that it adds to the discomfort of the patient.

This procedure saves the time required to perform the fifth step of the Coffey technique and that part of the sixth step in the male wherein the extra abdominal peritoneal tube for drainage is formed. Moreover no handles protrude from the abdominal incision nor from the vulva which is advantageous.

The second stage of the operation is a posterior resection of the stump of the rectum ischio-rectal fat levators and perianal skin. The patient is placed in the prone position with head and feet lowered. Sacral analgesia is used. The incision is made over the sacrum in the midline running around the anus and including a wide area of the perianal skin. The coccyx is removed. The dissection is made wide of the rectum. The levators are cut as far distal to the rectum as possible and much of the dissection can easily be made with the fingers following the line of cleavage caused by cutting off the blood supply from

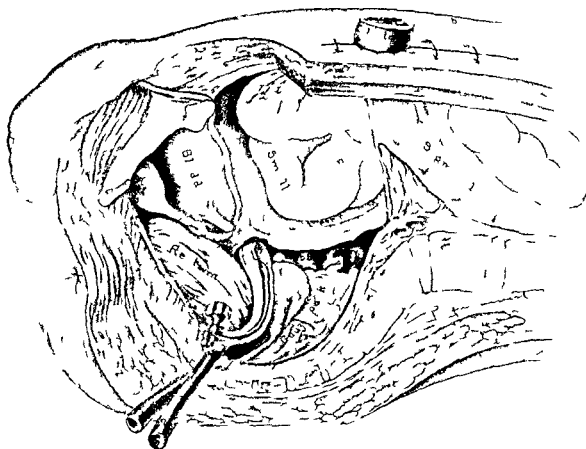


Fig. 4. The segment of sigmoid and rectum from the colostomy to the clamp has been removed the gauze pack placed in the pelvis and over it a piece of rubber dam the peritoneum and abdominal incision closed two rubber drainage tubes inserted into the cavity back of the mobilized rectum through an incision alongside the coccyx. The gauze pack should be placed completely around the clamp to protect adjacent tissues from any possible pressure.

above at the first operation. There is very little bleeding and that only from the skin and anal muscles. The clamp gauze pack and rubber dam are removed with the rectum and a surprisingly clean cavity is left. The cavity is then packed and healing is brought about by granulation. The patient is ambulatory after about 2 weeks.

This technique is equally applicable in the male or female in non obstructing or obstructing cancers and for growths located at any point in the rectum or lower sigmoid.

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been quite contrary to such theories and for that reason are here set down

It has been our aim particularly during the last few years of our operative experience with thyroid diseases to eliminate drainage in every possible instance and we have closed all thyroid wounds tightly except when the superior mediastinum had been opened when a considerable pocket remained as after the removal of a large adenoma or when an oozing existed that could be controlled best by means of a small pressure gauze pack. That drainage has been but rarely employed in our hands is evidenced by the fact that in the years 1905 and 1906 a total of 1810 thyroid operations of all varieties were done and of those but 20 per cent were drained. These figures include the introduction of drains of any variety even the introduction of small slips of rubber dam just beneath the skin flap when oozing in this flap cannot be adequately controlled as is the case often when the flap is raised a second time in two stage removals of the gland as by two separate hemithyroidectomies. If the figures merely included those in which drains were introduced down to the remnants of thyroid itself beneath the prethyroid muscles the percentage of cases drained would be very much smaller.

With this plan of non drainage following partial thyroidectomy we have not been disturbed by undue thyroid reactions our mortality during these 2 years has not been greatly elevated—in exophthalmic goiter 0.00 per cent in toxic adenoma 1.77 per cent—and we have been more and more convinced of the desirability of closing thyroid wounds without drainage except for definite technical reasons such as oozing dead space or openings leading into the mediastinum.

Should it be necessary to employ drainage we urge strongly against the use of stab wound drainage below the center of the incision as has been so commonly employed in the past. The scar which remains following drainage at this point is thick and is quite unnecessary. It is located so that it is very noticeable as it cannot be covered by heads.

We would also urge strongly against bringing the drain out through the center of the transverse incision for the removal of the thyroid. We employed this plan in the past and gave it up because of the fact that the scar tissue which filled in the midline drainage sinus so fixed the skin to the trachea and thyroid remnant that the median portion of the scar was often held up in a most unsatisfactory and disfiguring manner.

We have now for some time led the drain or

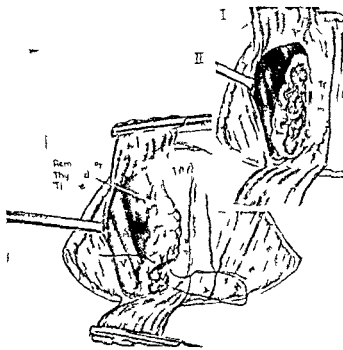


FIG. 2. I The illustration shows the remnant of thyroid tissue following the partial removal of the thyroid lobe. II shows the method of suturing the outer cut edge of the thyroid remnant over against the trachea so that all of the open surface of the gland is buried and the smooth posterior surface of the gland then presents. This results in complete control of all oozing and practically the reconstruction of a new lobe.

drains when it is necessary to employ them out through the external angle of the wound where the skin does not become adherent to underlying structures and no disfigurement results.

In certain cases in which the drains are to be brought out at the external angle of the wound it will be found that the sternomastoid muscles lie so far forward that the drain cannot be brought out without angulation. In these cases we have passed the drains through the bellies of that muscle by bluntly separating its fibers with scissors at the level through which the drain is to emerge.

Following non drainage after thyroidectomy we have not had accumulations beneath the prethyroid muscles requiring secondary opening and have not had difficulties with wounds breaking down. The postoperative thyroid reactions have not increased in numbers or in intensity and the operative mortality has not been high.

We have frequently had small pockets of serum accumulate directly in the wound scar 10 to 14 days after operation and occasionally sooner but have never had any difficulty in caring for them by evacuation of the serum with a probe for a few days when the patient returns to the clinic for dressings.

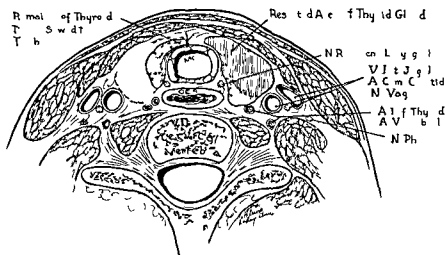


Fig 3. The diagram shows the thyroid gland and its relationship to the trachea and the surrounding structures. The thyroid gland is shown in cross-section, and the trachea is shown in cross-section. The diagram is labeled with various anatomical structures and their relationships.

We have occasionally had considerable accumulation beneath the skin flap itself. This has usually occurred within 5 to 6 days after operation and in the same way we have had no difficulty caring for such pockets by separating the wound edges at the most prominent point, evacuating the contents of the pocket and employing hot boric applications.

During the time we have been closing thyroidectomy wounds without drainage we have had no trouble with breaking down and separation of the sutured prethyroid muscles. Wound cannot be closed without drainage of course unless meticulous pains are taken to insure complete hemostasis and to obtain a very dry wound when the operation is completed. We have accomplished this by ligation of all small vessels in the skin flap and on the muscles to control oozing from these points and finally have controlled all oozing from the cut surface of the thyroid rem-

nant which is to be left behind by suturing the outer edge of the thyroid remnant to the pretracheal tissue as described by us in SURGERY GYNECOLOGY AND OBSTETRICS so that the cut surface of the thyroid is held firmly against the trachea and the smooth uncut posterior surface of the thyroid remnant presents uppermost on the reconstructed and remaining thyroid remnant.

CONCLUSIONS

Drainage following thyroidectomy is necessary only for technical reasons—to take care of uncontrollable oozing to eliminate dead spaces in which blood may pool and become infected and to protect the opened superior mediastinum against infection.

Thyroid reactions following operations upon the gland are no greater when the wounds are closed without drainage than when drained and in our experience are not related to this factor.

A BLOOD-VESSEL CLIP SET FOR INTRACRANIAL WORK

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FROM the time of the appearance of Cushing's clip forceps holder former and scissors up until 2 years ago we have been entirely dependent upon them for controlling hemorrhage of the cerebral vessels. Their use has been associated with varying success but unfortunately there were many instances when we met with great difficulty in handling them the clips were sometimes imperfectly formed as a result would not fit the holder properly and consequently could not be applied to the bleeding vessel successfully. A further cause of trouble we believe was the fact that wire was used with the result that the arms of the clip crossed when the clip was pressed together. For that reason ribbon has been substituted. Furthermore the stop pin used in this clip holder as described later prevents lateral movement of the clip and also prevents the clip from slipping away from the vessel when pressure is applied to the clip at its apex.

I have worked out a set of instruments for this purpose which produces a clip uniform in size and which any assistant can make without difficulty. The new outfit complete consists of a clip cutter (Fig. 1) a clip rack (Fig. 2b) and a clip holder (Fig. 3a and b).

The clip cutter is an instrument of tool steel which cuts a uniform clip of silver ribbon. This is accomplished by feeding the flat silver ribbon through a slot in the block of the cutter (Fig. 1a) and when the jaws of the cutter are closed the flat wire is cut and molded into clips (Fig. 1b). These clips are uniform in size and the length of

each side of the clip is identical i.e. the apex is equidistant from the base. These are placed on the rack (Fig. 2b) which has a broad corrugated base. The jaws of the clip holder are placed in the grooves of the corrugated base and the handles brought together (Fig. 2b). The holder is withdrawn and the clip is in place (Fig. 3c). The clip may also be picked up without unlocking the handles by slipping jaws over rack.

The jaws of the holder are counter sunk half the thickness of the ribbon and the pin in the jaw is machined out to the thickness of the clip (Fig. 3a arrow). The clip is held in place snugly by the jaws and pin thus preventing any lateral movement. The pin in addition prevents the clip from slipping up into the clip holder in experience that is not infrequent when holders without the stop pin are used. This important feature cannot be too strongly emphasized.

The making of clips with this instrument is very simple and it is well to make them up before an operation. Experience has shown that frequent boiling of the clip cutter dulls the sharp

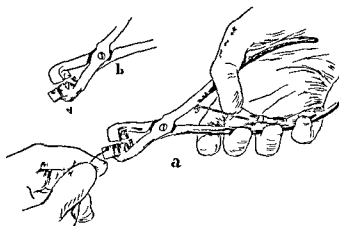


Fig. 1. Clip cutter and detail of instrument.



Fig. 2. Clip rack and detail of clip forceps.

edge of the tooled steel which makes the important sharp angulation of the clip. Passing the holder through saline after the application of each clip keeps the jaw clean and prevents the sticking of the clip in the groove into which it fits.

This instrument has been in use in the neurosurgical clinic of Washington University School of Medicine and Barnes Hospital for the past 2 years and was demonstrated to the members of the Society of Neurological Surgeons at their meeting in St. Louis in December 1926.

AN OVERHEAD FRAME FOR PLASTER BODY—SPICA CASES

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ANY case demanding an application of a plaster body cast with either single or double spica of the hips, thighs and legs is a great care from the treatment and nursing standpoint and frequently the patient suffers considerable discomfort. The prevention and treatment of pressure sores, the changing of the bed linen, any inspection of the perineum, buttocks or sacrum, any dressing of the back and the other usual daily nursing cares are problems of great concern. Cases of this type are frequently improperly handled, thus causing unnecessary pain as well as increasing the possibility of further damage to the patient.

We have found that the overhead frame here with described (Fig. 1 to 6) is a great aid in treating and nursing the plaster body—spica cases; furthermore, it eliminates many of the complications and difficulties encountered in such cases.

The frame is of very simple construction, consisting of 4 pieces of wood 2 by 4 inches and a crosspiece (3 by 15 by 15 inches) for extension on the legs when necessary. The frame fits any hospital bed and alterations can easily be made to fit any type of iron bed.

The frame is also useful for treating fractures about the hip joint and fractures of the neck and shaft of the femur, especially if extension is desired, either a plaster cast and extension or suspension and extension with the thigh and leg in a Thomas splint being used. We have used it to considerable advantage in fractures of the pelvis.

Figure 1 shows the patient suspended following application of sufficient weight to raise him off the bed. A shows crosspiece 2 by 4 by 8 feet 4 inches long which is attached to the foot and head pieces at CC. CC extends 6 inches beyond CC. CC at the foot and head pieces to allow the weights to clear the bed. Four 1/4 inch holes, inches apart, are made at points CC. CC on piece A to allow for any adjustment which may be desired of the crosspiece A to the head and foot uprights.

J shows head piece 2 by 4 by 45 feet long. H shows 2 foot up rights (see also Figure 4) which are the same dimensions as the head upright J. Two foot up rights are used to steady the frame.

H. E. C. H. F. t. (th. P. l. Sc. d. T. t.
I. F. t. h. d.

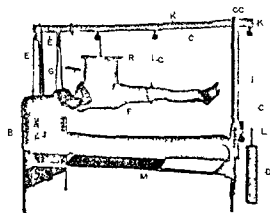


Fig. 1

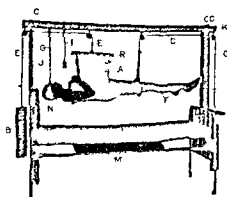


Fig. 2

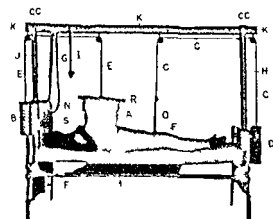


Fig. 3 Showing patient on bed. Weight from B and D have been gradually removed.

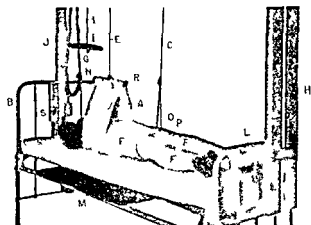


Fig. 4 Close up view showing detail of cast and suspension apparatus.

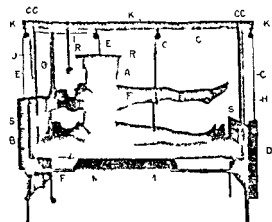


Fig. 5 Double exposure showing patient suspended and covered.

L shows foot crosspiece 15 by 15 by 38 inches. This is used in cases in which traction on the legs is desired. The screw pulleys are $\frac{1}{4}$ inches in diameter. W W show board splints used under the bed to prevent sagging of the mattress.

The patient is suspended with the head and foot weights D and B by attachments of rope C to the double plaster spica F F and rope E to the wooden piece R to which the muslin sling A is attached. I shows the muslin sling 24 inches by 6 feet which fits around the patient's body cast and at one end of the sling is a loop for the wooden piece R which measures 15 by 15 by 4 inches. Buckles and straps attached to the muslin sling A enable it to be fastened around R. The rope E is attached to the center of R.

G is a piece of bandage around the crosspiece K and has a large handkerchief A tied to each end for the head rest. I is a swing rope and broom stick for patient to pull himself up. S shows blocks (Fig. 5) 45 inches long by 15 by 15 which fit on each side of the upright iron rods on the foot and head of the bed and stabilize the frame.

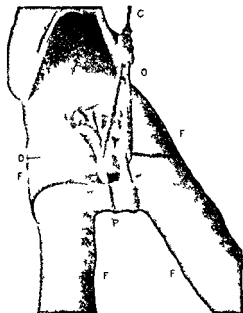


Fig. 6 Showing type of knot used in the rope O which is applied around the legs F F and the crosspiece P. This crosspiece P which is made of plaster should always be applied because it strengthens the cast as well as allows the patient to be moved painlessly.

It can easily be seen that if enough weight is applied to D and B the patient can be raised at any height from the bed without difficulty and can be suspended for a considerable length of time without great inconvenience to the patient. If any elevation of the patient's head and chest is desired weights can be removed from foot weight D.

Dressing of the perineum can be done easily. Any dressing of the back can be carried out by unbuckling the straps on the right or left side of muslin sling A depending on the location of the wound. The patient is perfectly comfortable and does not suffer from a suspension over a prolonged period.

CORRESPONDENCE

OPERATING RETRACTORS WITH THE FEET

To the Editor I wish to call the attention of abdominal surgeons to the advantage of operating their retractor with the feet instead of by hand.

The contrivance is simple. An ordinary gauze bandage is passed around under the table in a loose loop reaching to the floor; each end is fastened to a retractor by a strong thumb clamp. The feet of the operator treading upon or secured to this loop of bandage by motions right and left either of foot, toe or knee make desired traction.

A firm retraction of either or both, all of the round is thus afforded as desired entirely at the operator's command whether seated or standing. The maneuver with a little practice becomes quite automatic. An unobstructed view of the interior is obtained without obstruction of light. One or more assistants are dispensed with and the necessity for directing their action much time and difficulty is saved.

A more elaborate mechanism by which bandages are replaced by metal chains by which hooks, snaps or other holders grasp the retractors, a frame or movable calipers on the principle of a self-retaining retractor, foot pedal and clamp, adjustment attached to the base of the table through which the bands pass in order to hold them conveniently as

well as block and tackle pulleys to increase the retraction with less foot motion etc. have been suggested. Such detail could be left to an instrument maker should they be desired. Every

thing however which detracts from simplicity and asepticity should be dispensed with unless of marked advantage. If additional retraction in any direction is desired there is nothing to prevent an assistant making it when called upon to do so, but this is not usually necessary.

I am employing the method described in my operating room where it is being commented upon.

OSCAR KANE M.D. F.A.C.S.

K I VI

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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APRIL 1928

INFLUENCE OF PREGNANCY ON THE FUNCTION OF THE GALL BLADDER

IT has been observed clinically that pregnancy is an etiological factor in disease of the gall bladder. In 1911 W. J. Mayo stated that most women with disease of the gall bladder who have borne children date the onset of symptoms from a particular pregnancy. Pre-existing cholecystitis often undergoes exacerbation during pregnancy. It is not uncommon for attacks of gall bladder colic to become so frequent and severe or symptoms of acute or subacute cholecystitis so apparent that operation on the gall bladder must of necessity be performed during pregnancy. It has been demonstrated that such an operation may be done successfully and without undue risk.

It has been assumed that disease of the gall bladder during pregnancy is caused by an increase in the cholesterol content of the blood and a certain sluggishness of the biliary tract produced by pressure from the enlarging uterus. Mann and Higgins showed recently that the emptying time of the gall bladder in most pregnant dogs, guinea pigs and gophers

is delayed. Following the ingestion of the standard fat meal of egg yolk and cream (Boyden) the gall bladder of the pregnant animal of these three species emptied partially in early pregnancy and less completely as pregnancy progressed. Mann and Higgins believe that a larger number of pregnant animals of these and other species including man must be examined before it can be accepted as a physiological fact that the gall bladder of the pregnant animal is slow to empty. They conclude. However, three considerations are pertinent to the subject. The pathological conditions often associated with pregnancy which may directly or indirectly have some relation to the mechanism of the biliary tract are (1) hyperemesis (2) eclampsia and (3) gall stones.

Is this delay in the emptying time of the gall bladder the result of mechanical, chemical or nervous influences? The mechanical factor apparently has been ruled out. Is it the result of chemical changes in the blood due to pregnancy? Many investigators have attacked the problem of the cause or causes of hyperemesis and eclampsia from the chemical angle. Among these Hofbauer has shown that acute poisoning by histamine, a protein derivative, produces pathological changes in animals suggestive of those in women who die from eclampsia and that chronic histamine poisoning produces changes similar to those resulting from pernicious vomiting. Is it the result of action through the sympathetic nervous system? An indication of the influence of the sympathetic nervous system is the frequent observation that pylorospasm occurs during labor, preventing the downward

passage of food even throughout protracted labor. A case may be cited that of a woman who swallowed air and as a result her stomach became distended three times during the second stage of labor. Each time the stomach became visibly distended the patient complained of epigastric pain and the uterine contractions ceased until the stomach was emptied by tubing. Another clinical observation is the induction of uterine contractions following vigorous intestinal peristalsis such as that produced by castor oil. Is the retardation of the gall bladder function due to a similar mechanism? Is the delayed emptying of the gall bladder associated with physiological lowered hepatic function during pregnancy? Is it a part of a retardation or lowering of the function of the upper digestive tract? Artz has observed that gastric acidity is low in certain normal pregnant women and still lower in certain patients with hyperemesis. Is it due to or a part of reversed intestinal peristalsis which may occur during pregnancy?

ROBERT D. MUSSEY

TREATMENT OF POSTOPERATIVE HÆMORRHAGE FOLLOWING GASTRO-ENTEROSTOMY

HÆMORRHAGE following gastro-enterostomy, rare though it may be, is a most alarming distressing and embarrassing sequel to an otherwise satisfactory operation and it may tax the best judgment of the surgeon to carry on to a happy and successful outcome.

Hæmorrhage is most likely to occur either at the ends of the stoma or from one of the larger vessels along its margin.

In performing gastro-enterostomy the utmost care should be taken to obtain accurate approximation of the mucosa and to control the submucosal vessels. A lockstitch for the anterior as well as the posterior row of su-

tures is to be preferred the *anterior mucosal border being turned away from the lumen*. This is exceptionally important because cases of postoperative hæmorrhage have been reported in which the bleeding came from the anterior border due to an inverting mucosal suture which did not control the vessels (Horsley). When a definite vessel can be identified a double lock or back stitch should be used about it. When the gastro-enterostomy is performed without clamps and when all bleeding points may be seen and grasped the chances of postoperative hæmorrhage should be less. If clamps are used two simple straight intestinal clamps suffice. After the posterior row of sutures is completed and again after the anterior row is finished if any possibility of hæmorrhage still exists these clamps may be loosened any bleeding points may be seen and sutured or ligated and the clamps again tightened. This is especially advantageous when the gastric vessels are abnormally large or dilated.

Dean Lewis has suggested that he consider that the best hæmostasis is obtained with three rows of sutures: serosa, submucosa and mucosa.

When clamps are used approximation of the end of the gastro-enterostomy incision is facilitated by grasping a sufficiently large section of stomach and jejunum. Thus the stoma is made long enough and yet on rounding the corners tension on the suture line is avoided by not approaching too close to the clamps.

Slow or minor hæmorrhage, the vomiting of dark blood 8 to 10 hours after the operation with gradual tachycardia, require little more than the withholding of fluid by mouth, the intravenous subcutaneous or per rectum administration of saline solution, transfusion or occasionally lavage. For lavage a weak soda and salt solution at a temperature

of 10 degrees F is especially recommended by Horsley

But when hæmatemesis begins 3 to 4 hours after the operation with definite clotted blood and is repeated 3 to 4 hours afterward the pulse rate is increased and the blood pressure descends there is definite pallor and the hæmoglobin and red blood count show well marked hæmorrhage a more drastic and direct attempt to control and check the hæmorrhage must be considered—that is the advisability of obtaining direct control of the hæmorrhage through a gastrotomy incision must be taken under consideration

The patient is returned to the operating room Under local light gas or ethylene anesthesia the abdominal wound is reopened or a new epigastric midline incision is made the anterior wall of the stomach about opposite the gastro enterostomy is grasped and a longitudinal incision 6 to 7 centimeters long made into its cavity about midway between the lesser and greater curvature This incision is then held open by stay sutures or Allis forceps and small retractors The clots and debris in the stomach are gently sponged out or aspirated and the gastro enterostomy wound is grasped by placing a stay suture at each end These are drawn upon and the gastro enterostomy is inverted into the stomach lumen where a lockstitch of chromic catgut No 00 can be rapidly thrown around the entire circumference of the gastro enterostomy When the hæmorrhage is controlled the gastro enterostomy is again dropped back and the anterior gastrotomy wound closed with two or three layers of sutures

This procedure has been used in 4 cases with uneventful recovery

W L ESTES JR

A DE LUXE EDITION OF OLD BOOKS IN SURGERY

THE ever changing conceptions as to the practice of surgery constitute one of its fascinations As the centuries go by certain masterpieces live beyond the ephemeral contribution of their day and a study of these portrays the definite advances in our profession Some years ago Dr Alfred Brown undertook the selection and review in brief of the great books that mark some of the epochs in surgery These have appeared monthly in SURGERY GYNECOLOGY AND OBSTETRICS The material collected is so valuable that it is with pleasure we learn that Dr Brown now contemplates publishing the reviews in slightly amplified form with the beautiful reproductions of the frontispieces title pages and illustrations as they appeared in his isolated publications This collection will be published in an edition of about three hundred pages with attractive typography and wide margins and will be well bound in distinctive boards—a book that will appeal to all book lovers and make a valuable addition to the doctor's library or an attractive gift for his friends

It will be published by Dr Brown not primarily for profit but as a labor of love from one book lover to another The expense will be such that unless there is sufficient interest on the part of the profession as evidenced by subscriptions received in advance to cover at least the printing costs it will not be advisable for the author to bring out the book The subscription price will be eight dollars and it is hoped that those of our readers who are interested will write to Dr Alfred Brown 1618 Medical Arts Building Omaha Nebraska making reservations for copies

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W. L. ESTES, JR.

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MASTER SURGEONS OF AMERICA

PAUL FITZSIMONS EVE¹

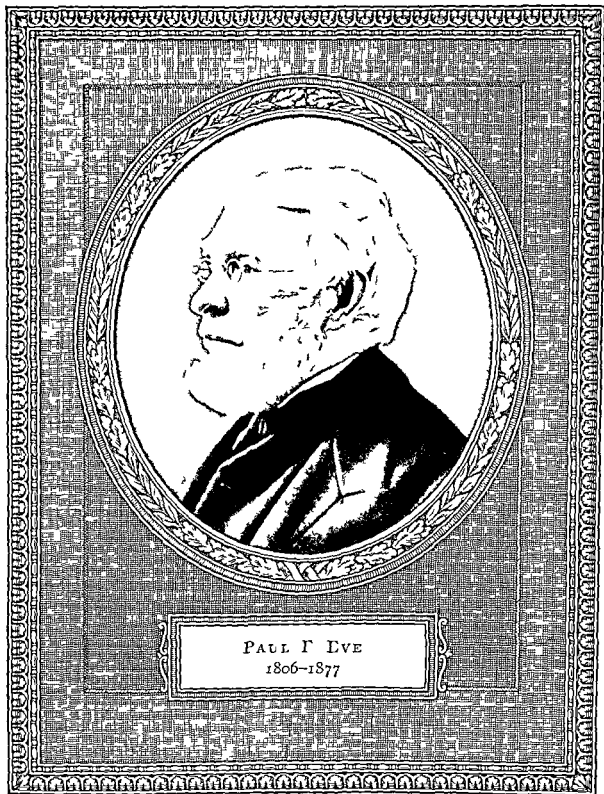
PAUL FITZSIMONS EVE A M M D LL D was born at Forest Hall on the Savannah River six miles below Augusta Georgia June 27 1806 He was the youngest of the eleven children son of Captain Oswell and Aphra Ann Eve On the father's side he was of English descent and on the mother's side was of the Scotch Irish blood His father had been captain of a Pennsylvania company before the War of the Revolution Captain Eve had as a schoolmate Dr Benjamin Rush

Paul F Eve graduated from Franklin College now the literary department of the University of Georgia in August 1826 receiving the degree of A B and the second honor in a class of twenty four This institution later conferred upon him the degrees of A M and LL D In Philadelphia he commenced the study of medicine as a private pupil of Dr Charles D Meigs and graduated in 1828

His original intention had been to remain in Philadelphia after completing the course of study and to practice his profession there He changed his plan because about the time of his graduation his aged father was seriously ill Returning at once to Georgia he gave his careful and unremitting attention to his father who died in 1829 and this act of filial devotion shaped his coming life for greatness He had in the meantime begun the practice of medicine in Augusta in June 1828

Dr Eve in November 1829 visited Dublin Belfast and London where he had letters to Sir Ashley Cooper Abernethy and others He reached Paris in February 1830 and remained there for 18 months following the course of instruction given by Larrey Dupuytren Roux Lisfranc Cruveilhier Trousseau R Cameron Andrae Ricord Louis and Velpeau who was used to introduce him as the tall American surgeon

Dr Eve was in Paris in May 1831 when all Europe was ablaze with turmoil and political excitement He witnessed the dethronement of Charles X in Paris and professionally participated in the revolution of the three days (July 27 28 and 29 1830) Then he went to Poland and offered his services to that unhappy country in its resistance to Russian oppression Remembering how the gallant Pulaski had fallen at the siege of Savannah during the Revolutionary struggle of



PAUL F EVE
1806-1877

1776 he earnestly desired to aid in paying that debt to distressed Poland. He, at length, reached Warsaw and was assigned immediately to hospital service. For his evident ability and his conspicuous devotion to duty, he was soon promoted from the hospital department to be field surgeon of the Fifteenth Regiment of Infantry and Surgeon of Ambulances attached to General Turno's division. The Golden Cross of Honor was also conferred on him on the recommendation of Count Placc, chief of the Medical Bureau. During the storming and capture of Warsaw on September 7 and 9, 1831, he was fortunately out of the city on duty. He was subsequently taken prisoner, however, and confined at Werschow for 30 days, after which he was released under plea of cholera. He reached Paris in October, and there rested and recuperated for several weeks. Sailing from Havre, he reached America after a tedious voyage of 53 days.

In June, 1832, Dr. Eve was elected professor of surgery in the Medical College of Georgia, just then organized in Augusta, and was there engaged in teaching for 17 years, bringing the college great reputation and prestige, and establishing his own fame as a teacher and surgeon.

In 1849 Dr. Eve was chosen professor of surgery in the medical department of the University of Louisville to succeed Dr. Samuel D. Gross, who went to Philadelphia. He delivered one course of lectures in Louisville, but in March, 1850, he resigned, and although solicited by the unanimous vote of the trustees, the faculty, and the students to remain, he returned to Augusta.

In 1851 the medical department of the University of Nashville was organized, and Dr. Eve accepted the chair of surgery. Thus he occupied until the fall of Nashville in 1862, and again after the end of the war until 1877, with the exception of 2 years spent in St. Louis, where he succeeded Dr. Joseph Nash McDowell in 1868 in the Missouri Medical College.

He could not be contented away from the South, and in 1870 he resigned and returned to Nashville, and lectured to the medical classes of the University of Nashville and of the Vanderbilt University, which then held joint sessions in the same halls. In 1877 he withdrew to aid in the upbuilding of a new school, the Nashville Medical College, afterward the medical department of the University of Tennessee. His death occurred during the beginning of his second course of lectures in this institution.

His success as a teacher and the fame of his teaching may be shown by the records. From the time of its organization in 1832, with 28 students, the Medical College of Georgia increased to 195 students in the session of 1849-50, the last year of Dr. Eve's connection with the institution. This number exceeded the highest ever before or since attained. So in the medical department of the University of Nashville, the number of students increased from 136 to 454 for the last session before the war—the largest class then assembled in any medical college in this country, outside of New York and Philadelphia.

In 1859 Dr Eve was on the battlefields of Solferino and Magenta and communicated to the profession his observations on military surgery through the pages of the *Nashville Medical and Surgical Journal*

In November 1861 Dr Eve was appointed surgeon general of Tennessee and later chief surgeon of General Joseph E Johnston's army he was also president of the Army Medical Board of Examiners When the fall of Nashville became a certainty and sudden evacuation was determined upon he went away leaving everything he possessed Fort Donelson had fallen Sunday February 16 1862 he left the city at 11 o'clock at night His family servants went with him although he advised them to remain Colonel V K Stevenson was with him nearly blind from inflamed eyes His whole family was out of the city having gone to Augusta to bury his infant child By this forced flight he lost all his property But he went with his own people into exile his instrument case under his arm almost his sole possession

After a hurried visit to Augusta to see his family Dr Eve returned to Chattanooga and was ordered to organize a hospital service at Atlanta He remained in charge of the Gate City Hospital there until just before the battle of Shiloh April 6 1862 when he was ordered to the front He did able and valiant service with the army there and subsequently at Columbus Mississippi where he was stationed for several months Then he was ordered again to Atlanta thence in 1863 to Augusta and for a time to Richmond Virginia After the surrender he returned to Nashville

After the death of his first wife Dr Eve married January 19 185 Sarah Ann daughter of Rev H D Duncan of Barnwell District South Carolina who survived him nearly 20 years By his second wife Dr Eve had 3 children Duncan Sarah and Paul F Paul F Eve Jr a surgeon of ability professor of surgery and dean of the University of Tennessee died in 1906

Dr Duncan Eve the eldest born in Augusta Georgia May 1 1853 has been president of the Mississippi Valley Medical Society and first vice president of the American Medical Association and has been since 1895 professor of surgery in the medical department of Vanderbilt University

It was in 1873 with all of his family that Dr Eve made his seventh and last trip to Europe

Dr Eve was one of the editors of the *Southern Medical and Surgical Journal* through the years 1845 to 1849 and was also one of the editors of the *Nashville Journal of Medicine and Surgery* from its establishment in 1851 by Dr W K Bowling another president of the American Medical Association to 1873

He also contributed to Johnson's *Cyclopedia* sketches of distinguished physicians of the South and Southwest to the number of 257 a wonderful accomplishment in itself His literary work was unremitting and reached the prodigious number of 436 papers articles etc the last of which was an address on the His

tory and Achievements of Surgery in the South and Southwest which he delivered before the International Medical Congress at Philadelphia on September 6 1876

In Nashville in 1857 Dr Eve was elected president of the American Medical Association In 1867 he reported to that Association at its annual meeting in San Francisco the synopsis and analysis of 100 cases of lithotomy performed by the bilateral method Altogether he performed 238 lithotomies and had at one operation removed 117 calculi successfully As a lithotomist he was perhaps without an equal in this or any other country Of all his bilateral operations for stone in the bladder only 11 patients died He published the successful performance of amputations of all classes without losing one case up to the fifty fourth the statistics of the major operations comprising 7 of the leg and 7 of the thigh He reported as 'Contributions to the Hip Joint Operations 20 amputations and 18 resections performed in the Confederate service He reported 3 cases of gunshot wounds in which the ball lodged in the vertebral column 2 patients still living with remarks on Division of the Spinal Cord without Death He devised an operation for varicocele and invented a cannulated needle for applying ligatures and sutures He was among the first to direct the attention of American surgeons to Esmarch's bloodless method in amputations

The calculi removed he preserved and presented to the Medical Museum of the United States Army The Surgeon General's office in Washington mounted each set of halves placing one set in the Museum and returning the other to Dr Eve The set belonging to Dr Eve was kept in the museum of the Nashville Medical College and was destroyed when the building burned They form in the Medical Museum a collection unequaled in the world as the contribution of a single man

In Professor Samuel D Gross's *History of American Medical Literature from 1776 to 1876* he says Professor Eve's collection of *Remarkable Cases in Surgery* as a book of reference possesses great value

When he was in his seventy first year Dr Eve wrote that at the University of Georgia at Athens where he took a 4 years course he never missed a recitation

Took two full courses in the University of Pennsylvania at Philadelphia never was tardy once or missed a lecture While I dare not say that I have done all that I could have done with the means afforded as a medical professor said in Paris when dying yet I hope I can truly declare that I have tried to do so It has ever been with a serious defect in two intellectual faculties sight and hearing I was born near sighted and defective in distinguishing colors The microscope has even been to me a sealed book so has auscultation My hearing is acute but I never could distinguish one note from another I know little or nothing of diseases recognized by differences in sounds or colors What I have done in or for medicine has been with these serious defects

To regular habits of eating sleeping and labor together with his total abstinence from alcoholic stimulants and tobacco he attributed much of his good health health so excellent indeed that for nearly half a century he had not lost a day by sickness and had reached his sixty eighth year before he felt any influence of age

Of noble stature and commanding presence with a splendid head and refined features illumined by the light of genius Dr Eve would have been a distinguished type in any group of the most intellectual of his fellowmen To mental qualifications with which he was plenteously endowed by nature he added the ripe scholarship of a close student His most notable characteristic socially was his kindly sympathy and charitable consideration for the younger members of his profession Dr Eve was a devoted Christian and adorned the church as he adorned his profession This nestor of Southern surgery fell dead between daybreak and sunrise while hastening to see a patient He was in his usual health and in full professional panoply when death summoned him November 3 1877 He fell literally in action with the harness on and

Another chief was carried
From life's battle on his spears
To the dim Valhalla cloisters
Of the ever living years

W D HAGGARD

Practica copiosa von dem

Achten Grunde des Irth Schindens mit funde dem
 Figuren darinnen etliche in potius valse vna ruten
 schindt vmd. Schindtstangang mit Gros sein
 Zien beschriben Durch 2. abar und dromari
 Schindt vmd dromari



THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN M.D. I.A.C.S. OMAHA, NEBRASKA

CASPAR STROMAYR'S HERNIOTOMY

THE ancient literature on herniotomy is rather hazy and uncertain as to the detailed technique of the operation. Going as far back as Celsus one finds vague statements concerning opening the scrotum, reducing the contents of the sac and tying it off, and this same indefiniteness and uncertainty persists in nearly all the well known writers up to the latter part of the sixteenth century. To be sure different methods are described. Albucasis as is to be expected uses the actual cautery and burns the tissues down to the bone. In this method of treatment he follows Avicenna and Rhazes and is in turn followed by Bruno of Longoburgo. Other writers—William of Salicet, Lanfrancus of Milan and Guy de Chauliac among them—describe dissecting out the hernia, clamping the sac cord and all and removing the entire mass. Still another group advocates the suturing of the neck of the sac with gold wire, the so called *point doré*.

It is interesting and noteworthy that none of these writers is at all enthusiastic about the operative treatment of hernia. When it comes to medical treatment and the use of appliances, bandages and plasters they give detailed directions as to technique. One cannot help but feel that the actual operative treatment with its attendant almost universal castration did not appeal. Guy de Chauliac states that he does not believe a proper herniotomy can be performed without castration. On the whole they seem to be willing to apply the Hippocratic statement concerning cutting for the stone to herniotomy and let others who are accustomed to it do the operation. With this indifferent attitude existing on the part of the educated members of the surgical profession it was only natural that a group of lay herniotomists should assume the burden of caring for this condition. If the responsible members let the opportunity slide by because the burden was too great, the irresponsible members were ready and willing to add another surgical procedure to their repertoire. Consequently herniotomy, lithotomy and cataract extraction were by mutual consent turned over to the itinerant surgeons who were poorly educated. In many instances they were mountebanks and as a rule wholly worthless and irresponsible tramps. The foundation of the College de St. Côme and division of surgeons into the classes of those of the long and short robe gave the itinerant surgeon a

certain standing and conditions began to improve. Brunschwig and Gerssdorff wrote their works about the beginning of the sixteenth century. The surgeon of the short robe began to study and impart his knowledge to his fellows and operations of election received a certain standing as compared to operations of necessity. Through the efforts of Pare, hernia as well as traumatic conditions received attention and in 1556 Pierre Franco published his first work on this subject. There appeared to be little more than Franco's work for a considerable time but in 1909 a manuscript was discovered in the City Library of Lindau Lake Constance which deals largely with the subject of hernia. This has been beautifully reproduced explanatory historical notes have been added by Dr. Med. Walter von Brunn, Professor of Medical History at the University of Rostock, and the book has been published by Idra Verlaganstalt G. m. b. H. of Berlin.

The manuscript was written and the figures were probably painted by one Caspar Stromayr of the town of Lindau in Lake Constance. The volume is dated July 4, 1559. It is dedicated to Petter Hafner who is described as wound cutting and eye physician of Zurich. This gives the only point of contact between Stromayr and the medical profession for this Petter Hafner married Anna Ruff, the daughter of Jacob Ruff or Rueff who wrote the famous *Schoen Lustige Trostbuechle* on obstetrics. Beyond this nothing is known of Stromayr or of his life. He must have been a lay surgeon for his work shows a knowledge which would have given him a standing among the well known surgeons of the world had he been a member of the regular profession. Moreover in his introduction to the reader Stromayr stresses the knowledge of the actual condition and the dexterity of the surgeon and deprecates the possession of letters of recommendation and seals and a knowledge of Latin as criteria of ability. In fact he gives the impression that his opinion of the so called educated physician was not particularly high so far as operative surgery is concerned. He shows interesting colored sketches of various types of hernia and of the operative procedures which he recommends. He does not perform castration and his operation is much like that of Franco.

The point to wonder at is that such a manuscript as this should have lain hidden for three and a half centuries.

A REVIEW OF NEW BOOKS ON GYNECOLOGY AND OBSTETRICS

By GEORGE GILLHORN M.D. F.A.C.S. ST. LOUIS, MISSOURI

WITH the sanction of the Editor I place at the head of the list a book that is neither gynecological nor even intended for medical men. Its author has previously published an extensive textbook on therapeutics which it was my privilege to review in these columns a few years ago. What attracted me to that book was not only the crystalline clarity of the presentation and the breadth of knowledge but also the style so beautiful as to be almost unique in medical literature. The author presented facts in such a way as to make them alluringly interesting. Furthermore the volume was permeated with a keen sense of pathos and humor which endeared it to a keen enjoyment.

The same features characterize the present volume which the author has intended for the use of the laity. The desire to know something about the body in health and disease is a sign of our time and if gratified and led into proper channels it is perhaps the best safeguard against the dangers of half-baked fad and fraudulent ulcers. In essence the book provides a sound foundation of normal and pathological physiology and when the lay reader has once acquired this knowledge he is bound to appreciate better and cooperate more fully with the efforts of his medical advisers.

The author divides his subject into four parts entitled respectively: The Human Body as a Unit, The Human Body as an Organism for the Conversion of Food and Air into Energy and to Tissue, The Human Body as an Organism for the Reproduction of Its Offspring, and The Human Body and Disease and in each of these parts the functions of the various tissues and organs their alteration by disease their interrelation in the body, etc. are explained in sub-chapters. This list of contents may appear rather too formidable for the average lay reader yet the author accomplishes his task in an altogether admirable manner never talking down to his audience though he has frequent recourse to familiar similes or experiences but lifting them up by means of his sound education to higher levels where the blindness and ignorance and grotesque misapprehensions of some days are banished and where mankind may more fully enjoy the fruition of a progressing civilization.

Now I do not believe in the millenium but I believe that those who come under the spell of this book will be better and serene and all enjoy their lives more fully. They will chuckle at the gems of humor which sparkle through the pages even as I have done as I read the volume from cover to cover. They will also be opened to the medical follies that beset us on all sides whether

they appear in the garb of so-called regular medicine or as thinly disguised frauds.

Let me give you a few selections for your delectation. If you follow very carefully the dictates of the Life Extension Institute you can live on the average one month longer than you would otherwise which period you will spend in bed flat on your back given explicit instruction to the nurse as to

how you want for pallbearers. Speaking of renal colic childbirth is usually set up as the universal standard of pain. I gather from careful research that a ordinary kidney stone colic is equal to ten childbirths and a miscarriage. Who would not agree with this estimate of the literature on the endorhines? Much of this both that intended for physicians and that intended for laymen is put forward with the solemn appearance of fact. Actually it is pure arm chair speculation. And of migraine like mercy or the fruits of science it fillets upon the just and the unjust. There is only one way to treat it—with contempt, an old Roman remedy. Penetration is a good adjunct, no little used in the treatment of disease.

There is a more positive tenor in his reference to the Rockefeller Foundation, the McCormick Institute and similar endowments and his advice to his lay readers some of whom may have funds which they would like to use for the benefit of their fellow human beings is that there is no way to use them more effectively than by the endorsement of medical research.

There is to me in this book a significance beyond its value to the laity. Think of most of our textbooks. How dry they are how difficult to plod through! Why must the acquisition of knowledge be made so hard? Here is a textbook on physiology in all its aspects of less than 400 pages including more than a hundred in true pictures written as fascinatingly as the subject itself is fascinating. And in truth if the average medical student knew only as much of the matter as is contained in this book he would know a lot more than he actually carries from school into practice.

TO the thousands of American gynecologists who have not yet had access to radium and acquired sufficient personal experience the book by Clark and Norris will be a most welcome message. I fear I know that the first attempt in this country to present the question of radium in gynecology in monograph form. We are introduced to the subject by truly excellent chapters on the physics of radium from the pen of Giacchino Failla, physicist to the Memorial Hospital in New

York Here the complicated physicochemical problems involved are cleared up for us as if by a magic wand and we are made to understand the intricate nature of the interaction between matter and radiation of ionization and other scientific factors which underlie the administration of radio active agents such as filtration and the ratio of susceptibility of different tissues

Clark and Norris now take up the story and tell us in the following chapter their clinical observations on the variations in susceptibility of different tissues They stress the importance of teamwork between surgeon pathologist and physicist for successful radiotherapy and insist on exploratory excision of tissue not only for the purpose of making an exact diagnosis at the earliest possible moment but also because the degree of maturity of the cancer cells will affect the method of treatment The danger of rapid dissemination following diagnostic excision or curettage appears to the authors less important than the advantages gained

Quite naturally the greatest emphasis is laid on the use of radium in cancer and there follow four chapters in which malignant tumors of the vulva vagina cervix and body of the uterus are discussed and valuable technical points are presented Of particular interest is the authors own method of cautery amputation followed by irradiation Their results are encouraging and should prove highly stimulating to American gynecologists

As to fibroids the authors take a standpoint very similar to the one taken by the reviewer some years ago In the question of cervicitis they have followed the lead of Curtis with pleasing results and their experience with membranous dysmenorrhea proves that this disease is after all not intractable We may finally mention the chapter dealing with pseudomyoma peritonei granuloma inguinale malignant ovarian tumors sterility and dysmenorrhea to indicate the wide scope covered in this monograph

To us who have known and loved John Clark it is a matter of sad regret that he did not live to see his book in print but he has left the work in the capable hands of his co worker Norris who has given a work of definite practical value not only to the gynecologist but also the general practitioner who may read therein how much can be accomplished with radium in gynecology

THE socialization of medicine has progressed in Germany much farther than in other countries For the past seven years graduate courses have been given in several German universities where federal state or local health officers school and factory physicians doctors attached to the courts police prisons or sick benefit lodges etc attend lectures on the various branches of medicine The small book before us entitled Social Obstetrics and Gynecology¹ is the crystallization of some of these

courses The author is internationally known as one of the path finders in gynecological physiology and has on his recent visit to the United States made many personal friends He desires to give his readers guide lines in their official sphere of action as far as gynecology and obstetrics are concerned The headings of some of the chapters will explain the scope of the work Regulations regarding the hygiene of the newborn the girl at school age dress of child and woman physical exercises for women and children determination of virginity and motherhood rape legal determination of sex criminality in women general sexual hygiene marriage prenatal and postnatal care social insurance instruction of midwives industrial diseases of women police supervision of prostitutes etc All these subjects are discussed briefly and with reference to existing laws and ordinances Some of these are of course specifically German and have no counterpart in our own legislation A surprisingly large part of the book however applies to conditions in our country as well and as thus far very little attention has been given to the social pathology of diseases of women in our textbooks the American reader will find the study of this unpretentious volume extremely stimulating He will also appreciate the simple and direct style which greatly facilitates the perusal of a book in a foreign language

IN the six years which have elapsed since the first edition of Young's Gynecology appeared quite a few advances in our knowledge have necessitated a re writing of parts of the book Thus we find in the new edition² a discussion of the Rubin method the cyclic changes in the ovary and their bearing on menstruation the curative value of radium the endometrial transplants of Sampson and other subjects A volume of only a little more than 300 pages might well appeal to the student A future edition might be made still more attractive by deleting certain obsolete matters or modifying statements such as the assertion that gonorrhoea can be cured by three or four douches daily of potassium permanganate 1/8000 In favor of the book and of prime importance to the student who is being initiated into this field is the wholesome emphasis which is laid on pathology and diagnosis and the differential diagnosis too for instance in uterine cancer or tumors of the ovary has distinct merit

THERE is no such thing as a sexually frigid woman—that is the leitmotif of Steckels extensive work³ on anaphrodisia in women Passion may be hidden inhibited repressed or transposed into other channels but it is never wholly absent In these days the art of loving is on the decline

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The most marked evidences of this fact may be observed in America where the man is so busy with money getting that love is relegated to a second place. In America too so called sexual anæsthesia is very common among women. Yet the hypocrisy of the New World is well known an exaggerated prudishness on the surface and underneath indulgence in the vilest passions in such unheard of forms as orgies with Negroes and Chinese.

This quotation which proves the danger of generalization from sporadic instances of sexual depravity will show the American reader that not every statement in this book can be accepted at face value. But it could be wrong to condemn the whole work because of a few exaggerations or misstatements. On the contrary we have every reason for learning something about the psychic phenomena in our patients and in the quest on of dyspareunia in practice every careful observer will admit that mechanistic explanations the only ones which are discussed in our gynecological textbooks are not sufficient in all cases. I dare say that we are already receding from a too one-sided standpoint and that suggestions for curing masturbation or frigidity by excision or some other operation on the clitoris which formerly seemed quite legitimate nowadays appear to us ridiculous and medical.

It seems to me that Steckel who is a prominent psychoanalyst in Vienna goes to the other extreme that is he explains most gynecological diseases and practically all disturbances of the sexual life by psychological factors. We must however concede that he offers plausible solutions of a good many problems that have heretofore baffled us. There is for instance the oft made observation of husband and wife who have lived in sterile wedlock for years and after divorce each beget children in a second marriage (p. 320). There is the question of effluvium seminis (p. 112) of painful cohabitation in the absence of tangible causes (p. 197) of the psychic etiology of certain forms of vaginal discharge (p. 322) or of imaginary pregnancy (p. 530) and others too numerous to mention here. To offset this we are stirred out of our unreserved acceptance of the author's views by a sentence such as this: "To be raped by her own father has been the wish or dream of perhaps every girl at one time or other in her life."

The study of this book therefore requires a good deal of critical judgment and only with this proviso might the microscopy of the soul as expounded by the author be made useful for the diagnosis and treatment of some of our gynecological problems.

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THE PRECANCEROUS CHANGES IN THE RECTUM AND COLON

By J P LOCKHART MUMFERY FRCS LONDON

S r s g t St M k H p t l

AND

CUTHBERT DUKES MD MSc LONDON

D t C Res b D p tm t (St M k H p t l)

ONE of the greatest difficulties in studying the etiology of cancer from a clinical standpoint is that the disease is seldom seen except in the late stages when the growth has already reached a considerable size it is not until then that symptoms are produced Thus but little is known of the early stages in the development of malignancy and the changes in the normal epithelium which ultimately result in the transition from the normal to the malignant tissue are still but little understood This is true of all cancers but our study of precancerous conditions has been confined mainly to cancer of the large gut

In the vast majority of cases of rectal cancer there is nothing in the patient's history pointing to any previous condition which might be a forerunner of the tumor It has been surmised by some writers that long exsistant piles either internal or external may give rise to cancer if neglected but we have never come across any cases which would seem to lend credence to such a view It might well be supposed that chronic pruritus ani might lead to the development of epithelioma of the anal skin but we rarely have a case in which this has occurred although epithelioma of the vulva is not an uncommon result of pruritus vulvæ

Chronic fistula does occasionally appear to act as an exciting cause of cancer and we have records of two cases in which a carcinoma arose at the inner opening of a chronic fistula On the other hand we have seen fistulae which have existed for as long as 50 years without the development of cancer Chronic constipation has been said to be a predisposing cause but there is no satisfactory evidence in support of this view It must be admitted that apart from adenoma we know of no condition in the rectum which predisposes to cancer with any frequency

It has been increasingly evident in recent years that the etiology of malignancy cannot be elucidated by the histological study of fully developed tumors and that it is necessary to go further back and study the changes which occur in the epithelial cells before this stage of malignancy is reached This histological study of the changes which precede the development of cancer in the human subject is handicapped by the difficulty of obtaining suitable material nevertheless notable progress has been made in such investigations Thus for many organs of the body chronic hyperplastic changes such as those Sir Lenthal Cheate has described in the mamma have been recorded as commonly preceding cancer In this paper we shall



FIGURE 1. Illustration of the mucous membrane of the large intestine showing a simple adenoma. The mucous membrane is smooth and rounded, and the adenoma is a small, rounded elevation.



FIGURE 2. Illustration of the mucous membrane of the large intestine showing a simple adenoma. The mucous membrane is smooth and rounded, and the adenoma is a small, rounded elevation.

provide pathological and clinical evidence that similar epithelial proliferations frequently precede cancer of the rectum.

It is now a well established fact that adenomata of the mucous membrane of the large intestine are peculiarly liable to undergo malignant change. The following case will illustrate this process.

CASE 1. A gentleman 58 years of age was brought by his doctor to see one of us (P. L. M.) on account of a tumor in the rectum. The tumor was about the size of a two shilling piece, sessile and soft and was situated on the anterior wall of the rectum about 3 inches above the anus. A careful microscopic examination of the tumor after its local removal and after several sections had been cut from different parts of the tumor showed the structures of a simple adenoma. There were no signs of malignant change. The patient returned home after being instructed to have periodic examinations made. He neglected to follow this advice and was not seen again for 15 months. He then had a malignant tumor in the situation of the previous adenoma. It seemed certain that the adenoma had recurred and had subsequently undergone rapid malignant change.

The best clinical examples of the simple adenoma which undergoes malignant change and develops into typical carcinoma are seen in those rather rare cases of multiple adenomata or adenomatosis. This curious disease has a familial tendency in fact it is a true Mendelian dominant furthermore malignant change in one or more of the tumors always occurs. Such cases afford us an opportunity of studying the precancerous condition and have been of the greatest value in this connection.

In 1903 one of us (P. L. M.) stated that simple adenoma whether single or multiple should be considered as a definitely precancerous condition and treated as such. Since then much evidence has accumulated to con-

firm this view. The histological examination of large simple adenomata by cutting several sections from different parts has not infrequently demonstrated commencing malignant change in one part of a tumor which was otherwise benign in character. We need not dwell longer on this point since the frequency with which cancer begins in adenomata is now more generally admitted and in a recent paper one of us has reviewed from the pathological aspect the relationship between simple and malignant tumors of the large intestine. In the bibliography we append references to the articles which have appeared in the last years in each of which the close relationship of adenoma to carcinoma is emphasized.

RELATION OF EPITHELIAL HYPERPLASIA TO ADENOMA

If the piece of bowel which is removed by the operation of excision for cancer of the rectum is pinned out immediately to prevent distortion and after fixation in 10 per cent formal saline examined with a low power microscope or powerful lens the mucous membrane will often show irregularities in contour not visible to the naked eye. We have noticed these irregularities particularly in two pathological conditions—multiple adenomatosis and early cancer of the rectum. On section and microscopic examination of such an area of the bowel the irregularity is seen to be due to a localized epithelial hyperplasia. The hyperplasia may be so slight as to be quite invisible to the naked eye and only detectable on microscopic examination (Fig. 1) or it may be large enough to be noticed as a tiny smooth rounded elevation (Fig. 2). This irregularly distributed hyperplasia represents the first stage of tumor formation.



Fig. 3. Adenoma of the rectum. One of many tumors found scattered over the mucous membrane of the rectum in a case of early cancer.

and we wish to draw attention particularly to three points with regard to it: (1) that it is found most frequently in association with multiple adenomatosis and cancer of the rectum, (2) that it is more likely to be found in the neighborhood of a small malignant tumor than a large malignant ulcer, and (3) that it affects an extensive area of the bowel several inches above and below the cancer.

No sharp line of distinction can be drawn between this hyperplasia and adenoma in practice; we reserve the term adenoma for a glandular tumor visible to the naked eye and class as hyperplasia similar changes on a smaller scale only visible on magnification. Histological examination of adenomata (Fig. 3) proves that they represent only a more advanced stage of hyperplasia necessitating an architectural modification in the normal relationship of epithelium to connective tissue in order that the greater number of secreting cells can be supported and adequately nourished.

SEQUENCE OF EVENTS IN THE DEVELOPMENT OF CANCER

If it were possible to preserve a record of the condition of the mucous membrane of the rectum for several years before the appearance of a malignant tumor, we believe that in the majority of cases the following stages would be noticed in sequence, though naturally the number of years elapsing between each stage would vary greatly from patient to



Fig. 4. Malignant disease commencing in adenoma of the rectal mucous membrane. The malignant change is limited to the top and one side of this tumor but cancer cells are to be seen also invading the submucosa (indicated by the arrow).

patient. *First stage* localized patches of hyperplasia invisible to the naked eye but discoverable with the microscope affecting an extensive area of the bowel. *Second stage* the appearance of a crop of sessile adenomata scattered over as wide an area as was affected by the initial hyperplasia. *Third stage* the development of cancer either in one of these pre-existing adenomata (Fig. 4) or in the neighboring epithelium. *Fourth stage* the progressive enlargement and dissemination of the malignant tumor accompanied by retrogression of the hyperplastic changes and benign tumors surrounding the malignant growth.

THE PRECANCEROUS STATE

Both experimental and clinical observation have shown that the onset of carcinoma is commonly preceded in different organs of the body by a precancerous condition of the epithelium. In the rectum this precancerous state is distinguished by irregular patches of hyperplasia of the mucous membrane and adenomatosis. This does not mean every patch of hyperplasia will evolve into an adenoma or every adenoma into a cancer. The hyperplasia may disappear, an adenoma may become pedunculated and be shed, or

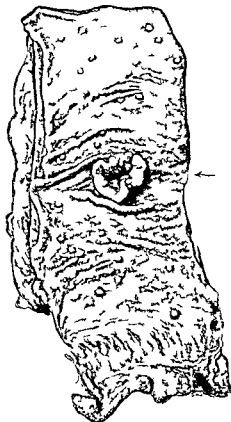


Fig 5. Cross section of the tumor removed by Dr. Ma
t. Not the small size of the tumor, but the growth with it
ced by the adenoma, and the adenoma, the adenoma
the use of the rectum. Localized epithelioma
hyperplasia, but the adenoma, the adenoma
but the adenoma, the adenoma, the adenoma

at any stage the onward march may be arrested. In experiments upon mice we find that not every mouse painted with tar develops papillomata and not every papilloma becomes an epithelioma; nevertheless we can say that the common sequence of events when mice are tarred is hyperplasia, papilloma, and epithelioma. The papilloma is the precancerous stage in experimental tar cancer and the adenoma is the precancerous stage in human rectal cancer.

We cite the following clinical evidence in support of this assertion:

CLINICAL EVIDENCE IN SUPPORT OF CONCEPT OF A PRECANCEROUS STATE

The following cases illustrate what we regard as stages in the development of cancer of the rectum.

CASE 2. A patient 66 years of age was admitted to St. Mark's Hospital with complaint of bleeding from the rectum. The first symptom was noticed only 14 days previously when after an urgent call to defecate the patient observed that he had passed a little blood. Sigmoidoscope examination showed a small tumor in the rectum. A perineal excision was performed.

The piece of intestine removed at operation is shown in Figure 5. The tumor was about 1 inch in diameter and projected 1 inch above the surface of the bowel. The mucous membrane of the rectum above and below was covered with adenomata, most of them about 3 inch in diameter. When the mucous membrane was stripped off the submucosa it was obvious that the tumors consisted entirely of an epithelial hyperplasia and were not caused by a bulging inward of the submucous coat. No adenomata could be counted in 1 square inch of the bowel above the growth and they were almost equally numerous elsewhere.

Microscopic examination showed the central tumor to be an adenocarcinoma. The cancer cells were seen to have invaded the submucosa but none was found within the muscle wall. The small tumor round about were seen to be composed of glands of mucus secreting epithelium and were true adenomata.

This case is specially noteworthy because of the early stage of the cancer as shown by its small size and brief history, and because of the wide spread adenomatosis which we believe to be a special feature of early malignant disease of the bowel.

CASE 3. A patient 47 years of age was admitted to St. Mark's Hospital complaining of bleeding from the rectum. He gave a history of bleeding and loose movements for about 3 months. Cancer of the rectum was diagnosed by sigmoidoscopic examination and a perineal excision was performed.

The specimen removed at operation is shown in Figure 6. The cancer had the appearance of a shallow ulcer 1 inch in diameter, extending half way round the bowel wall. The mucous membrane above the growth was dotted with nodules there being on the average 6 to 8 tumors per square inch. They were less numerous below but were seen almost as far down as the mucocutaneous junction. Microscopic examination showed the tumor to be an adenocarcinoma infiltrating the muscle wall of the bowel. The adenomata had the same microscopic characteristics as the adenoma.

CASE 4. A patient 67 years of age was admitted to St. Mark's Hospital complaining of long night for 7 months and diarrhoea with increasing loss of blood and mucus. Cancer of the rectum was diagnosed and a perineal excision performed.

The piece of intestine removed at operation is shown in Figure 7. In the upper part of the rectum

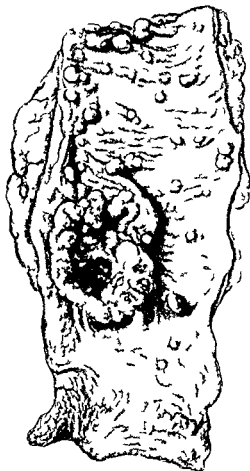


FIG. 6. Cancer of the rectum associated with adenomatosis. Note the extensive area of the bowel which is covered by the benign tumors and the comparatively small area affected by malignant disease.

was a large fungating ulcer $3\frac{1}{2}$ inches in diameter which had extended almost completely round the bowel wall (tumor A). At the lower extremity of the rectum was another large irregular fungating growth extending completely round the bowel and obviously composed of 3 or 4 separate tumors united into one mass (tumor B). Between these large upper and lower tumors 3 other separate tumors $\frac{1}{2}$ to 1 inch in diameter projected from the bowel wall. The intervening portions of the bowel wall appeared to be healthy. Microscopic examination showed the upper and lower tumors and the largest of the 3 intermediate tumors (tumors C) to be adenocarcinoma; the submucosa beneath each being invaded by malignant cells. The other tumors showed no indignant changes. Thus in this case 3 separate malignant growths and several benign adenomata were present in the rectum and sigmoidoscopic examination revealed other tumors in the sigmoid flexure of the colon.

Multiple foci of cancer in the rectum are not common. We have collected a few specimens at St. Mark's Hospital of 2 separate malignant growths but this is the first instance of 3 malignant growths in the rectum.



FIG. 7. Cancer of the rectum accompanied by adenomatosis. In this case 3 separate malignant tumors (A, B, and C) are present. Beneath each the submucosa is invaded by cancer cells but the intervening tissues show no infiltration. This is a case of cancer supervening on a adenomatosis; the malignant disease commencing at 3 separate places.

The following case illustrates the extensive area of bowel which may be affected by adenomatosis and the value of the discovery of adenomata as suggesting neighboring malignant disease.

CASE 5. The patient was a gentleman 58 years of age who came to have a large pedunculated adenoma removed from the rectum. At operation an adenoma as large as an orange with a long pedicle attached about 4 inches above the anus was easily removed. It was then discovered that there was another adenoma quite as large as the first impacted in the upper part of the rectum. This was removed with considerable difficulty as although it was pedunculated it was so large that at first it could not be pulled past its own pedicle which was attached below it. After the removal of the second adenoma a sigmoidoscope was passed

and a third adenoma as large as the others was seen in the sigmoid flexure. The abdomen had to be opened so that this adenoma could be removed. It was situated in the lower third of the sigmoid colon and part of it had undergone malignant change and involved the bladder wall.

As an illustration of the fact that adenomata occur as the result of a hyperplastic change which has affected an extensive area of the mucous membrane the following case is of particular interest.

CASE 6. A gentleman 62 year of age came for treatment of a large adenoma high up on the posterior wall of the rectum. Local removal of the mucous membrane including the adenoma was made and the patient has been carefully watched since. During the course of 6 years from the time of the original operation four adenomata have been removed at different times. None of these adenomata was in the strict sense a recurrence as none of them arose in the situation of the original tumor but in other parts of the rectal mucous membrane some distance away.

Another exactly similar case has been under observation for 5 years and 4 different tumors have been removed none of which was in the situation of the first tumor.

Had these patients not been examined at regular intervals large tumors would have developed which would have been certainly looked upon as true recurrences. The truth seems to be that adenomata once removed do not tend to recur in the same spot but other adenomata tend to develop in the neighboring mucous membrane. In other words they arise as the result of the occurrence of progressive hyperplastic change not in one spot but in a fairly extensive area of the bowel epithelium.

If this view of the sequence of events is correct the condition we have described as multiple adenomata is one that should be watched most carefully. One of us has shown in an article on Cancer and Heredity how frequently cancer is associated with multiple adenomatosis and has explained the apparent hereditary tendency to rectal cancer in certain families as due to the familial incidence of multiple adenomatosis. Since multiple adenomatosis is so frequently an early stage in the development of cancer it is imperative that a patient in whom this condition is dis-

covered on sigmoidoscopic examination should be kept under strict observation.

SUMMARY

The earliest recognizable lesion in the development of cancer of the rectum is a hyperplastic change taking the form of irregular epithelial proliferations scattered over an extensive area of the bowel.

This is followed by the appearance of visible tumor—adenomata—these are usually numerous and often separated from each other by several inches of mucous membrane normal in appearance to the naked eye. We have called this the precancerous stage.

The bowel may remain in this condition for many years or at any stage in the epithelial proliferations or at any stage in the growth of an adenoma the epithelium may abruptly assume those invasive properties recognized clinically and histologically as cancer.

It would appear that carcinoma formation is an accident happening to a previously existing adenoma. With the development and dissemination of the malignant tumor the neighboring epithelial proliferations and benign tumors tend to retrogress and disappear so that they are less evident in association with large malignant ulcers.

These opinions are supported by pathological and clinical observations.

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1. ATER N M Polyp d cancer f m d 1 n
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THE FATE OF IODIZED OIL (LIPIODOL) IN THE LUNGS

By A. LINCOLN BROWN, M.D., SAN FRANCISCO, CALIFORNIA

F mth D p tm t fS g ry M G I U ty M t l d d the p f D Edw d A h b l d

THE introduction of iodized oil in the form of lipiodol into the field of radiology by Sicard and Forestier (6) in 1922 has been followed especially of late by its widespread use in the exploration of the bronchial tree. Reports are now available from numerous clinics where fairly large series of cases have been injected. But scientific therapeutics presupposes an intimate and exact knowledge of the physical and physiological effects upon the organism of the substance administered from the moment it enters the body until its elimination is completed. Although as a rule the use of a drug is to be deplored when this knowledge is incomplete still if the drug has been shown to possess certain advantages then its use must be condoned until further light either strengthens or weakens the authority for its administration. This is the present state of affairs with respect to the intratracheal injection of iodized oils.

It is known that certain dangers exist in the introduction of the material into the tracheobronchial tree (1). The knowledge of the absorption, elimination and physiological action of the iodine component of the mixture is relatively complete. But the same cannot be said of the oil portion. Therefore the experiments reported in this article were undertaken with the aim of studying (a) the reaction if any of the finer structure of the pulmonary tree to the presence of iodized oil and (b) the fate of the oil portion of the combination. In these experiments the French preparation lipiodol was employed. This consists of a vegetable oil, huile d'olive, and contains besides 40 per cent of iodine by weight. The iodine is said to be in chemical combination with the oil which combination breaks up slowly once the oil is in the body but is otherwise fairly stable. Forestier has shown that after an intratracheal injection of 20 cubic centimeters of lipiodol the daily elimination of iodine (mainly via the urine) during the first weeks is about 2 centigrams.

The iodine makes its appearance in the urine in about 10 hours.

The recent work of Roger and Binet (4) suggests that the lung possesses besides its usual function of filtering gases an internal digestive power which is most strikingly exhibited in its action on fats. In their investigation they make use of intravenously injected oils and they believe that the fat is altered by a true intravascular digestion in which oxidation plays the most important role. Their observations however were concerned with the fate of oil on the blood vessel side of the air capillary membrane while we are dealing with oil introduced into the air side of this system. The experiments of Guéysson (3) extended and confirmed by Guyot throw some light on this phase of the problem. They injected small amounts of purified olive oil intratracheally into the lungs of rabbits and made histological preparations of the lungs 1 and 4 days after the introduction. They found that after 24 hours the drops of oil in the alveoli were in a state of decomposition, were irregular, jagged and filled with vacuoles and that by the fourth day this process was still more marked. They believed the oil to be absorbed by the epithelial cells of the alveoli. However when they used larger doses of oil they found that a certain number of the epithelial cells detaching themselves from the alveolar wall phagocytized the oil and migrate through the adventitia as far as the lymph nodes. On the other hand Sicard (6) states that the oil which remains in the lungs for longer periods of time probably becomes encysted. It seemed to the writer that further experimental work in this direction was worth while.

EXPERIMENTAL METHOD

Lipiodol was introduced into the tracheobronchial tree of cats under light general anesthesia by the intercostothoracic route. A small syringe was first attached to a heavy needle and the latter inserted into the



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f l The cat l g i a b h l l t d f m
3 t 6 l k d mpty l l ab L n 6 m l l
m t s u f 8 t m s b l w 15 n h t n S d
III

I g C t 4 Ph t m c g ph f p t f th
mo l r l l l t F h g th
f e t t f d f th ph vt f l O l m m e r s n
l 8 t m l b l l h s d n III t

trachea its position being determined by the free aspiration of air into the syringe. This syringe was then replaced by another containing warmed lipidol and 2 cubic centimeters of the oil were introduced. The injection was carried out with the cat fastened upon an animal board and placed on an inclined plane of 30 degrees head up so as to facilitate the flow of the oil into the finer bronchi. In some instances cough was induced shortly after injection. The trachea was compressed at the same time as this procedure has been shown to further the penetration of the oil. (2) X-ray pictures were taken in each case shortly after the injection to make clear the presence and general position of the oil in the tracheobronchial tree and were repeated at intervals of 1 to 3 days throughout the remainder of the life of the cat the excellent radiographic properties of the oil rendering it peculiarly adaptable to this phase of the work. The cats were then killed by bleeding at various intervals from 1/2 hour to 60 days after injection and autopsied the lungs in each case being preserved in 10 per

cent formalin. A glance at the last X-ray picture of the lung in question usually demonstrated the portion of the lung containing the oil in greatest amount and histological sections were taken through that area in which the presence of the oil had been demonstrated at some previous time. Two series of slides were made one the usual hematoxylin and eosin preparation to demonstrate any cellular reaction and the other frozen sections stained with Sudan III or Scharlach K and mounted in Farrant's solution to demonstrate the oil itself. The sections were cut thick (to 35 microns) so that the larger droplets of oil would not fall out.

The detailed typical and histological findings in the experiments were carefully noted. In all cases roentgenogram taken shortly before the death of the animal demonstrated the iodine component of the oil to be present in larger or smaller amount. Actually this amount appeared to vary a great deal by subsequent microscopic examination in direct proportion to the amount of oil found in the tissues. That is although the absorption and elimination of the iodine proceeded at a more rapid rate than the oil still the more oil there



Fig. 3. Cat 4. Photomicrograph of a portion of the pleura. The dark staining elements collected especially just beneath the pleural surface are mononuclear phagocytes filled with droplets of oil. Lens 16 millimeters 8 times ocular 20-inch bellows Sudan III stain.

is in the tissues the more iodine is also present.

From these histological studies it appears that phagocytosis is a prime factor in the absorption of oil from the alveoli and that these phagocytes then transport the material by way of intercellular migration to lymphatic channels and lymph nodes. The cells concerned in the process of phagocytosis are large mononuclear cells apparently of endothelial origin. In the earlier days after introduction of the oil these cells are most prominent in the neighborhood of the oil-filled alveoli and in the alveolar spaces themselves while as the process progresses they are observed also in large numbers collected in groups in the lymphatic areas and nodes and finally even after the alveolar spaces have got rid of the oil these groups of phagocytic cells containing the oil still stand out prominently.

It was noted that the distribution of these oil-containing phagocytes during the process of migration (Fig. 1) closely follows that of the lymphatics of the lung as described by Schriefer (3). The passage reads as follows:

Lymphatics. The veins are accompanied by lymphatics which commence both in the



Fig. 4 (left). Cat 4. Twenty-four days after the lipiodol injections. In this cat injections were performed at the outset the first intratracheally and the second into the subcutaneous tissues of the neck. That in the lungs still persists in a finely spread state in the middle and lower right lobes. It is from this area that sections were taken for microscopic examination. The mass in the neck is well defined and microscopic sections here show the oil to be well encapsulated. No such process of encapsulation was noted with respect to any of the oil in the pulmonary tissues.

Fig. 5. Cat 1. Four days after the introduction of lipiodol. Roentgenographic shadows show the oil to be present in large amounts in the middle and lower right lobes. Sections for microscopic examination were taken from this area.

interalveolar tissue and under the pleura and pass to lymphatic glands at the root of the lung. Others which eventually join these accompany the arteries and others are found in the walls of the bronchial tubes. There are no lymph vessels distal to the lobular bronchioles. The lymph vessels of the bronchi send branches to join those of the pulmonary arteries and veins; these communicating branches come from the end of the lobular bronchioles and from the places where the bronchial tubes branch. The atria and infundibula (air sacs) have no lymph vessels in their walls. The lymphatics of the lung often contain large mononuclear leucocytes (phagocytes) with carbon particles in their interior. The carbon particles are introduced with the air of respiration and appear to be conveyed

from the interior of the alveoli into the pulmonary tissue by the agency of leucocytes which are often seen in sections of lung within the air cells (Fig 3)

The rate of removal of the oil appears to be in direct proportion to the number of these phagocytic cells which may be marshalled into action in any given area. Thus if there be only a small amount of oil in a given region it is quickly removed whereas if many neighboring alveoli are filled with oil the process is markedly prolonged probably because of the lack of sufficient phagocytes to expedite the work as well as of a mechanical block of tissue and lymphatic spaces (in which the phagocytes migrate) by the pressure of the oil (Fig 3)

In no instance even when oil was found in alveoli after a period of 4 weeks was there any evidence of encapsulation of the oil. This encapsulation has been suggested as being the fate of oil remaining in the lungs for long periods of time but we are unable to adduce any confirmatory evidence on this point. In contrast to this we have observed encapsulation of masses of oil injected into the intermuscular spaces of the neck to take place as early as 1 week after the introduction of the oil.

Although the most important factor in the removal of the oil appears to be a process of phagocytosis comparable to the removal of dust particles from the alveoli there is probably also a certain amount of direct absorption of oil by the lining cells of the alveoli themselves but this appeared to be of secondary importance. Perhaps there is also a certain digestion of oil and absorption into the blood system as suggested by the work of Roger and Binet but there is no evidence in support of this in the material at hand nor did we note any vacuolization of the oil in the alveoli as suggested by Guixysee

DETAILED HISTOLOGICAL FINDINGS

CAT 1 (Autopsy 4 days after introduction of oil)
A (Slides stained for oil) Lipodol is scattered in a state of fine division throughout numerous alveoli some of which are completely filled with the oil. Apparently oil is also absorbed by the endothelial cells of the alveoli and is collected in large masses in the connective tissue around the smaller

bronchi and pulmonary veins. Nowhere do droplets of oil appear vacuolated. In those areas where lipodol is found in greatest amounts there is a marked infiltration of leucocytes most of which are mononuclear several being of the large phagocytic variety and many of which show oil inclusions. In some areas the pleura shows collections of the oil in a very fine state of subdivision. Here also it is mainly present as inclusions within large mononuclear phagocytes.

B (Hæmatoxylin and eosin slides) Small hæmorrhagic areas are scattered throughout the lung along with the cellular infiltration of the tissues which is predominantly mononuclear in character. In the same areas are noted masses of yellow brown staining material which is similar to hæmosiderin in appearance. This cellular infiltration is especially marked around the pulmonary vessels and bronchi. No thickening of the pleura is noted although the infiltration and hæmorrhage extend directly up to the pleural surface.

CAT 23 (Autopsy 24 hours after introduction of lipodol)

A (Slides stained for oil) Large areas of the sections examined show many of the alveoli completely filled with the oil. The others containing in greater or smaller amounts. Throughout the involved areas a moderate leucocytic infiltration primarily of the large mononuclear variety is noted. The cytoplasm of many of these cells is filled with minute droplets of oil. In some instances these cells are observed in what may be supposed to be the actual process of phagocytizing the oil. However no vacuolization or putrefaction of the large droplet by these phagocytes is noted. The phagocytic cells are observed both free in the alveolar spaces and also apparently in the process of migration through the pulmonary tissues. In those areas in which only a few of the alveoli have been filled with the oil the process of phagocytosis has proceeded most rapidly and here also are noted large numbers of phagocytic cells. These cells are likewise collected in groups about the walls of the bronchi. Immediately beneath the pleural collections of the oil containing mononuclear phagocytes are also seen.

B (Hæmatoxylin and eosin slide) In some areas there is a marked mononuclear infiltration. These cells correspond to the phagocytic type and are found in greatest numbers about the walls of the alveoli and in several instances in large amounts free within the alveoli. A few of these cells contain one or more vacuoles. They are also noted scattered just beneath the visceral pleural surface.

CAT 4 (Autopsy 24 days after introduction of lipodol)

A (Slides stained for oil) Small droplets of oil are scattered throughout large areas of the lung. Many of the alveoli are almost completely filled with phagocytic leucocytes whose cytoplasm numeously fine droplets of oil are noted. In some instances the whole cellular structure of the lung is apparently permeated with the very fine droplets. About the

nuclei of the cartilage cells and in the cytoplasm of these cells are collections of oil. The pleura is thickened and covered with an exudate which likewise contains large amounts of oil finely subdivided. In some areas there is evidence of old hæmorrhage and throughout the regions involved there is observed leucocytic infiltration predominantly mononuclear in character.

B (Hæmatoxylin and eosin slides) The areas about the pulmonary vessels and bronchi show a marked infiltration in which large mononuclear cells predominate. The pleura is thickened and infiltrated throughout with these cells. In other portions the lung has completely lost its structure and contains milary abscesses.

SUMMARY AND CONCLUSIONS

An iodized oil (lipiodol) was injected intratracheally in 2 cubic centimeter amounts into the lungs of healthy cats. These cats were killed anywhere from $\frac{1}{2}$ hour to 26 days after the introduction of the oil and histological studies of the lungs undertaken. From these studies it appears:

1 That the presence of oil in healthy alveoli excites a mononuclear infiltration of the area involved.

2 That this mononuclear infiltration is of the large phagocytic type apparently endothelial in origin.

3 That these phagocytes are the prime agents in the removal of the oil from the alveoli and that they follow the lymphatic system while direct absorption or digestion of the oil if it occurs at all is of secondary importance.

4 That at least up to 4 weeks there is no evidence of encapsulation of the oil remaining in the alveoli and

5 That the rate of removal of the oil is in direct proportion to the number of available phagocytes.

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FURTHER STUDIES ON CLOSURE OF BRONCHI IN LOBECTOMIES (EXPERIMENTAL WORK)

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KARL TANNENBAUM M D D E SLOBE M D Chirg go
F m th D p rtm f E m l S g y N thw U t y M d l S hoo

IN a paper written by one of us several years ago¹ experimental evidence was advanced to show that it is difficult to close bronchial stumps after pneumectomy because the structures which go to make up the stump are in themselves unable to close the bronchus. When a bronchial stump heals it does so usually because of the activity of some extrabronchial tissue most frequently the pleura from adjacent lobes. In our experiments at that time we reported a series of dogs in which after a complete pneumectomy the vast majority died suddenly on the fifth or sixth day because of the failure of the bronchial stump to heal. It took about 5 days for the ligature which closed the bronchus to slough and allow the bronchus to re-open. As long as the bronchus was held closed by the ligature the dogs were in good condition. As soon as the stump sloughed and the bronchus re-opened the dogs died from internal pneumothorax. In this series one dog survived and later was killed. Microscopic section showed that the bronchial closure was accomplished by a very thin membrane and it was a source of surprise to us that the membrane had not torn on the first paroxysm of coughing.

In this same article we reported a second series of experiments in which instead of removing the entire lung on one side we removed only one or two lobes of the lung leaving one or more lobes in place. The great majority of our dogs lived. On autopsy it was found that the bronchial stump had become buried in adhesions usually derived from the pleura of contiguous lobes and that these adhesions derived from peribronchial tissue had closed the stumps. The actual tissues in the stump itself had not been active in the healing process. We made the statement at that time that although the main bronchus was ex-

remely difficult to close and that complete one-sided pneumectomy almost invariably resulted in death on the fifth or sixth day due to opening of the stump a lobectomy on the other hand was easily tolerated. This second statement of ours has been frequently misquoted so frequently that we deemed it advisable to perform a new series of experiments to prove our conclusion that lobectomy in a dog is easy to perform and well tolerated and that the bronchial stump is closed by being firmly embedded in adhesions derived from peribronchial tissue.

The work here to be reported consists of 3 series of experiments.

1. A series of lobectomies carefully done with insufflation anæsthesia the main bronchus being ligated to a lobe with silk or catgut the vessel to the same lobe ligated separately with silk or catgut and the lobe being amputated just distal to the ligature.

2. A series of lobectomies carefully done both vessels and bronchi being ligated with the same mass ligature and an appreciable amount of tissue being left distal to the ligature. Open drop ether was used for the series.

3. One dog in which a careful complete one-sided pneumectomy was performed.

SERIES 1 consisted of 7 dogs. Anæsthesia was obtained by tracheal ethyl ether insufflation. The chest cavity was entered by an intercostal incision. One or another lobe of the lung was exposed and delivered to the wound. With a small aneurysm needle the vessels and bronchus were caught and ligated separately distal to the lobe to be amputated. Only enough tissue was left distal to the ligature so that the ligature could not slip. After the lobe was amputated the lung re-extended and the animal closed. In some cases the intertracheal space was approximated by the ribs the catgut suture in the ribs the muscle only re-sutured. The skin was closed by means of a intracuticular stitch. The collar.

Of these 7 dogs only 1 died from opening of the bronchial stump. The dog died on the fifth day and presented the same findings as in our previous

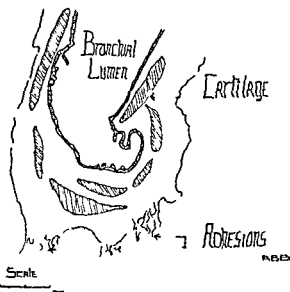


Fig Camera lucida trac'n from a typical case (Series 1 Dog 2) showing the dense adhesions which bury the stump. The stump is blunt. The mucosa has completely regenerated. The cartilage at the tip of the stump stains very faintly and is probably cartilage which was turned over by the crushing action of the ligature.

reports namely a clear pleural space, no emphysema, no free fluid in the pleural cavity but a widely open bronchial stump. Death was sudden and due to internal pneumothorax.

One dog died on the fifth day but to our surprise not only was the pleural cavity clear but the bronchial stump was closed and the lung could be inflated with a syringe without any leakage of air. Careful autopsy showed no pathological conditions which might have caused death. The cause of death therefore was not determined.

The 5 remaining dogs all survived, were well and were killed 23, 46, 53 and 60 days respectively after operation.

On examination the pleural cavities were found normal, no adhesions were present except in 2 dogs in which a fine string-like adhesion rose from one of the lobes to the site of pleural incision. The pleural scar in all dogs was barely discernible. The lungs filled the pleural space. The bronchial stump was very difficult to find, the stump being buried in adhesions and usually covered by one of the remaining lobes of the lung.

In short in this series the majority of our dogs survived lobectomy and the stump was found to have been buried in adhesions. Therefore we again maintain as do practically all other writers that dogs survive lobectomies and the closure of the bronchial stump is aided by connective tissue derived principally from the surrounding structures adjacent lung lobes.

SERIES 2 consisted of 6 dogs. Lobectomy was performed by mass ligation and a larger (than in



Fig The suture point to the bronchial stump of the amputated lobe deeply buried in adhesions.

Series 1) amount of ligated stump tissue was left. The operation consisted of an intercostal thoracotomy, a lobe being delivered through the wound, the hilus of the lobe being ligated and the lobe being amputated in such a manner that a fairly large amount of lung tissue remained distal to the ligature. Four died from the reopening of the bronchial stump: 2 on the sixth day, 1 on the eleventh and 1 on the eighteenth. The other dogs who survived this period died of distemper: 1 on the twenty-first and 1 the fifty-fourth day.

The tissue distal to the ligature was thus deprived by ligation of the vessels of its blood supply and became necrotic. The necrotic tissue prevented the closing of the stump with the peribronchial tissue. We are aware that it is equally true that the necrotic tissue would have interfered with the healing of the bronchial tissues themselves and therefore we are not advancing this as an argument to prove the nonhealing qualities of the tissues. We performed this series of experiments because we thought that the remaining pleura would be able to block off the bronchial stump even in the presence of necrosis and that the pleura would be sufficiently resistant to cope with the small amount of infection.

THE ANATOMICAL BASIS FOR THE STUDY OF SPLANCHNOPTOSIS

THE ABDOMINAL WALLS AT TERM

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 F. m. t. h. l. b. t. y. f. t. h. n. w. l. k. l. y. g. i. n. h. o. p. i. l.

OUR knowledge of the prenatal evolution of the abdominal walls is still incomplete. It is known that the viscera are developed first. Later these are surrounded by a membranous wall into which still later from the dorsal toward the ventral surface wander the muscles, these latter carrying with them their nerves and some of their blood vessels (F. P. Mall). The viscera draw within the walls and take up certain positions within the abdominal cavity thus formed. The walls surround the viscera and follow them in their changes, being more or less voluminous as the volume of the viscera is greater or less.

As the child develops within the uterus it retains more or less of its dorsad convexity, the growing internal specialized parts (viscera) gradually becoming enclosed within the anterior concavity, while the growing external specialized parts (upper and lower extremities) turn forward and fold up upon the walls—the whole forming an ovoid mass suspended in fluid, the flexed head coming to be predominantly directed downward (Fig. 1).

As the child passes from this phase of existence its liquid surroundings disappear and as it is born it emerges unsupported by any close modifying medium into the wide ocean of the earth's atmosphere and directly subject to the laws there existing. It tends to fall into a more or less horizontal plane, spontaneously assuming a supine, prone or lateral position, or some combination of these positions.

THE ABDOMINAL WALLS AT TERM

When the child at term is laid upon a table in the supine position it tends spontaneously to assume a certain attitude, i.e., the dorsad convexity tends to disappear and the spine tends to straighten, the head falls to one or the other side in some degree of flexion and lateral rotation, the upper extremities fall to the side of the trunk in some degree of

abduction, the elbows are more or less flexed and the lower extremities assume an approach to the quadrupedal position, the thighs being more or less flexed, abducted and rotated outward, while the knees are flexed so that the feet (heels) tend to approach each other in the median line (Fig. 2 a b g h i, Fig. 3 a b e f g j, compare with Fig. 2 c d e f).

Resistance is encountered if an attempt is made to change these positions to those assumed in the most advanced postnatal evolution of the individual, i.e., head midway between flexion and extension so that the face lies in a plane parallel with the anterior plane of the trunk and lower extremities extended, adducted and rotated inward so that the patella look forward. Resistance is also met in abduction of the arms beyond a right angle with the trunk. If these resistances are overcome the accomplishment of these later evolutionary positions is accompanied by changes in the trunk, including especially the abdominal walls.

Therefore the study of the abdominal walls makes it necessary to study more or less the conformation of the child as a whole, i.e., certain details of the spine, thorax, pelvis, head and upper and lower extremities. This study is first made in the spontaneous position, as already outlined, while later are noted the modifications which accompany the making of the advanced postnatal positions described.

THE TRUNK AT TERM

Shape of the trunk, anterior, posterior, lateral and profile views. In the supine position, viewed from above, the general shape of

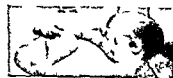
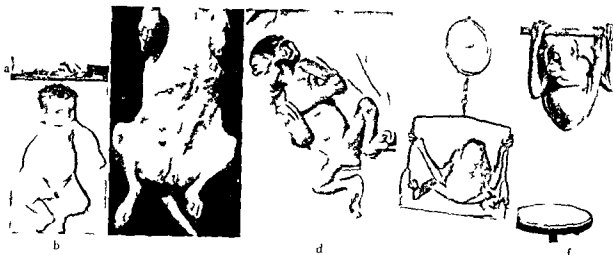


Fig. 1. Attempt to restore a child stillborn at term (9 XMI) to the intra uterine position, profile view.



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fa ly typ c l t n t i f m l u e t th spont e u
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h d f l e d n d t a t d t o d the low t m t s
r e f l d a b d t d n d o t a t d t w d b Phot ph
f c h l d s t l l b m t t e m (g L L V) h w g f l y t y p c a l
p t n f t h l e g t t r m d e t n t r a t n f t h f r a
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e d f o n b o The p t n f i l t u n b d t a
n d t w a r d r t t o n o f t h l w e t r m t e s d u t
f t r a l m s c l o c t e f o l d w e l l a t c n t r a t s
f t h d p e t d Phot ph o f m l c h m p n
w h i h d e d a l m t s s s t w a b o r n s h w n p o t n
t t r m f m r k e d f i e o a b d u c t i o n d t w a r d r t
t o o f t h l w e r e x t r m t e s e P h o t o g r a p h o f a f e m a
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s h w i n f n c t u l u s f u l e a b h m a n t f

t m e f l o b d t d t w r l r o t a t f t h
l o w t m t g P h t g p h f a l g h u l f d y
l d (B 6 a) Th p t f m k d i l a b u t d
o t w d r o t a t i f t h e l t r m t i s m m t y
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h w f l y t y p c a l s p t u p t o f t h e l
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a d d u t a d w a r d o t a t f t h l f t t m t
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f i b u t i s s m r e a d m e t t h d m t h p o s t n a t l
o l t a f t h m t y p N t h m p e t r y
f r w a d a d d w n d t a t o o f t h p l u s t h l m b t h
c u l o d t h a n t n b d m a l p t r u s a d t h e
f r w d a d p r d t a t n f t h t h o r a g
(d e d f p h t g r p h t h g h c o t y o f w l k
Z o o l o l p k)

the trunk is bluntly fusiform and flattened more or less from before backward (in the early hours after death the abdomen is usually more or less rounded anteriorly as well as laterally) sometimes the central enlargement is prolonged upward and downward resulting in a barrel shaped figure sometimes the lower pole of the spindle is enlarged laterally giving a square or rectangular shape to the lower trunk. The lower pole of the spindle appears to be bounded in front by the suprapubic groove and the trunk appears to terminate in a waist which is marked anteriorly by this line and laterally by the apex of the trunk thigh lateral angle (Fig 2 b g Fig 3 a c f)

The upper limits of the trunk are obscured and made to appear square or rectangular by the shoulder girdle and the muscles connecting the trunk with this girdle. When the shoulder girdle is removed the true shape of the upper pole of the trunk is seen and the upper pole of the spindle is seen to be the smaller (Fig 3 d compare with c e)

Viewed from the side the front profile of the trunk (Fig 3 f i to j) shows an anterior curve which is markedly ovaloid the convexity of the curve rapidly increasing from the sternal notch downward to reach its maximum in the neighborhood of the lower end of the gladiolus or the upper epigastric region. From here the curve as a whole rapidly decreases as it passes downward to the symphysis though sometimes it is broken by a slight secondary convexity near the umbilicus. In this position the child appears to rest upon the table in an unbroken line from occiput to buttocks the lateral walls of the abdomen tending to project more or less laterad and dorsad obscuring line of spine

In the prone position viewed from above (Fig 4 a b) the entire back appears square or rectangular narrow downward as to waist at or just below the crests of the ilia at the trunk thigh lateral angle. This apparent waist line marks the lower pole of the spindle and is continued anteriorly by the suprapubic groove. It is also marked medially by a more or less pronounced receding sagittal open angle (lumbosacral angle) with more or less irregular transverse surface grooving. The lower pole of the trunk posteriorly (loins) is materially broadened or narrowed by the presence or absence of a pyramidal mass of fat which fills the joint and extends downward over the upper part of the ilia to join the general increase of fat from there downward over the buttocks (Fig 4 b)

A in the supine position the upper limits of the trunk are obscure and made to appear square or rectangular by the shoulder girdle and the muscles connecting the trunk with this girdle. When the latter is removed the true shape of the upper pole of the trunk is seen and the upper pole of the spindle is again seen to be the smaller (Fig 4 c)

Viewed from the side the back profile (Fig 4 d e) shows a long oblique line or a long very slight curve with convexity dorsad. In either case the line is limited by two slightly receding angles with apices directed ventrad the upper angle being at the junction of the head with the trunk and the lower a little below the crests of the ilia (lumbosacral angle). Caudal to this latter angle the continuing line rather brusquely becomes quite convex because of the rounded dorsad of the buttocks. In this prone position the front of the trunk rests on the table in an unbroken line from point on sternum below the notch where the bone falls into contact with supporting surface.

It is difficult to place the trunk in the lateral position its tendency being to fall more directly prone or supine according to the position and weight of the shoulder and pelvic girdles and according to the position of the upper and lower extremities which enter into the supporting base.

The tendency is more toward the prone position because of the tendency of the arm to fall forward and make traction in the same direction on the scapula and upper trunk. When the forearm is extended and the whole upper extremity placed directly on the side of the trunk the latter seems to incline a trifle toward the supine position on account of the weight of the scapula and its attachments.

When the trunk is balanced as well as possible midway between pronation and supination and viewed from above the anterior outline (front profile) of the trunk appears ovaloid the longer arm of the curve being cephalad and extending from the neighborhood of the sternal notch to about the level of the ninth rib in the midclavicular line from this point the curve may maintain its maximum or even slightly increase for a short distance then it rather rapidly decreases to the symphysis pubis.

The posterior outline (back profile) may appear straight or it may show a slight posterior or convexity extending from the base of the cranium to the end of the buttocks this curve being broken at about the level of the crests of the ilia by a slight receding angle with its convexity anterior (lumbosacral angle). This receding angle varies in size with the degree of tension of the thigh's upon the trunk. When the thighs are all flexed this angle practically disappears and the straight line or posterior convexity of the spine may appear to be continuous. The posterior line may be modified by variations in the balance of the trunk.

Trunk markings Viewed from the front the salient trunk markings are the trunk thigh lateral angle the suprapubic groove the groin grooves secondary transverse grooves variable muscle markings variable periumbilical fat cushions an occasional ensiform depression and an occasional costal margin groove (Fig 3 b g h i compare with c d Fig 3 a b d e)

The downward tapering of the trunk ends laterally at or just below the crests of the ilia. Here an obtuse angle opening out ward and perhaps also more or less forward is formed by the junction of the trunk and the thigh. The apex of this trunk thigh lateral angle (which may be more or less blunted) is usually situated at about the level of the

TABLE II b—FETAL CASES TRUNK MEASUREMENTS VERTICAL HEIGHTS AND FRACTIONAL TRUNK HEIGHTS ANTEROPOSTERIOR AND TRANSVERSE DIAMETERS GIRTHS

Fetal Case	7 x II	6 x IV	6 x X	6 x IX	A 6 m	5 XI	4 XVII
Weight (gm)	68	545	95	585	693.3		5
Height (mm)							
Vertebral	45	38	36	3.8	35.6	74	7
Sacral	34		55	7	34.6	9	
Gluteal	80	87	3	98	6	67	97
Natal	5	61	94	60	75.3	48	83
Umbilical	17	4	68	54	54.6	3	7
Illeal	8	4	6	44	40	4	
Symphysis pubis	78		4		3.3	3	59
Trunk diameter (mm)							
Anteroposterior	5	36	30	7	34	7	
Transverse	3	7	94	8	8.6	45	4
Third posterior	63	45	49	4	45	39	
Fourth	7	47	6	54	54.3	45	
Gluteal							
Anteroposterior	68	47	5	43	47	41	
Transverse	84	50	7		63	5	
Natal							
Anteroposterior	68	45	5	4	46.3	47	
Transverse	94	57	8	66	68	57	
Natal							
Anteroposterior	65	4	5	38	41.6	46	
Transverse	9	56	83	67	65.6	53	
Umbilical							
Anteroposterior	58	31	43	34	37	45	
Transverse	8	48	75	56	59.6	45	
Illeal							
Anteroposterior	48	34	41	33	36.6	38	
Transverse	8	49	69	53	57	45	
Width of base of triangle at tenth rib (mm)	8	4	79	6	6.6	5	
Gluteal							
Natal	55	68	5	76	86.3	5	
Natal	60	69		79	9	53	
Natal	5	59	0	75	4.3	5	
Umbilical	5	4	5	64	7.3	3	

corresponds with the conjoined shape of the viscera which it contains and its increase and diminution correspond with the increase and diminution in volume of these viscera—the bases of the lungs the diaphragm the right and the left lobes of the liver the stomach spleen pancreas duodenum jejunum ileum transverse colon splenic flexure and upper part of the descending colon probably the adrenals and perhaps the upper portion of the left kidney (Fig 3 a to e)

This division is predominantly ellipsoidal swelling out laterally in the midaxillary line from the sixth to the tenth ribs the maximum being from the seventh to the ninth or tenth ribs. There is also a more or less marked anterior rounding which having begun in division 1 at about the level of the third or fourth rib continues downward in this division to about the level of the ninth costal cartilage (Fig 3 f to j). There is moderate variation in the form of this division depending on variations in the size of the liver and in the volume and amount of distention of the stomach and intestines.

Division 3—from about the level of the ninth costal cartilage at the costal margin to the suprapubic groove in front and to a little below the crest of the ilium laterally. The shape of this division corresponds with the size and volume of its contained viscera—

jejunum ileum ascending colon cecum lower descending colon sigmoid colon perhaps sometimes the adrenals usually the greater portions of the kidneys the bladder fundus uteri and ovaries and perhaps redundant transverse ascending or descending colons (Fig 3 a to e Fig 4 a to c Fig 2 g h)

This division is predominantly a section of an ovoid but at the sides it always tends more or less to overhang the crest of the ilium. There is a fair amount of variation in the form of this division making toward a square or rectangular effect depending upon the volume and amount of distention of the intestines particularly the sigmoid colon and also upon the amount of subcutaneous adipose tissue. It rounds out anteriorly rather than laterally any redundancy of its contents tending to travel forward rather than laterally or backward (Fig 3 f to j). However after a certain anterior limit is reached it then rounds out laterally becoming more square or rectangular and overhanging its lower boundaries.

Predominantly then the trunk appears to consist of a truncated quadrilateral pyramid (division 1) blending at its base with a section of a more or less flattened ovoid (divisions 2 and 3) the latter tapering downward to the top of the symphysis pubis in front (suprapubic groove) and to a little below the crests of the ilia laterally. Occasionally the ovoid

TABLE II c.—CASES AT TERM

F t	l t	n k	b ghts	f m	h	mphys	9	9-	9 IX	9 XI	9	XXII	9 XXV	III	9	XXVI	9 XV	A	8
Ce	se						3	3	3	3	3	3	3	3	3	3	3	3	3
S m	l	b					99	79	63	65	74	65	69	53	6	5	6	6	6
C d	l								9		6	6	3						
Ninth	t l	l g					88	8	80	9	8	9	8			65	60	58	58
Umbil							53	5	44	48	5	53		3		46	3	45	45
Symphys	o b																		
tr	k b	g bts	f m	l	l	th	t												
bo							4	36	43	56	3	9		3	6	6		58	58
S l	h						55	57	44	44	58	5	45	7	5	6	3	5	5
G l	d	l	tch				56	4	39	3	33			3		39	33	3	3
N m	h os	I	t f	gl d															
Umbil		h ost	l	l g			35	3	36	45	3	5	57			9	5	45	45
S mphy	mb l						53	5		45	5	5	3	43	4	6	3	45	45

narrows less gradually resulting in a more square or rectangular appearance

Pr po is —Post i ly th o tl a d bou d es f d o i a bs ed by th c p læ nd th co n ct m le Whe these a d cted away th tr at d q drl te l py am dal sh pe s e The lat al outl n of d l s b lge fu the o tw d f m th y l d g f th l te al lls to the pr of th nt d po t or w lls Th t r wall flatt d by th g at r t c of the tabl n wh ch th hld t and the po t w lls fall t w d th t bl o t f th own weight nd th weight f th scer D s n 3 h ows m lar lat l b lgn but p dom a tly th d w w d tap g al ady d ted Whe th l we d ons a q a rect ngul th l te l b lgr g m e ma k d (F g 4 to c)

Heights of the three divisions of the trunk
Considerable individual variation exists in the heights of the divisions of the trunk (Table I) as calculated from the fractional trunk hughts (Tables II a II b II c II d) these variations being roughly but not exactly related to the vertex height of the child and being similar throughout prenatal life from the fourth month onward

All th m m t n Tables I to III pt the tex le ht r t k w th h d t d d th t f e l s n the f tal pl e a d w th lo t m t p t eo fl bdu to d tw rd otat Th h ht f d v o r e t t m fr m 34 t 58 m m t s d 6 f tal c e fr m 5 t 35 m m t r d n f m 3 to 56 m m t e and f m 4 t 37 m m t s th t g oups pe t ly wh l d n 3 r e f o m 60 t 9 m m l uet s a d f o m 4 t 4 m m t s e s p e t ly

Division 3 always predominates in height division 2 is most often shorter than division 1 (from 5 to 17 millimeters at term from 1 to 4 millimeters in the fetal cases) (7 of 9 cases at term 4 of 6 fetal cases) occasionally it is the same or a trifle greater (2 of 9 cases at term 2 of 6 fetal cases)

Diameters of the three divisions of the trunk
A study of Tables II a and II b shows that as far back as the sixth month the antero posterior (dorsoventrad) diameter of the trunk proper is on the whole shortest at the level of the umbilicus or sometimes at the level of the crest of the ilium in the mid axillary line (the umbilicus is sometime on the same level as the crest of the ilium sometimes it is cephalad to this level) It is absolutely the shortest in all except of the 11 cases at term and 1 fetal case at the fifth month

I thes 3 ca s (9 xv 9 iv 5 x) th ho t st te p te d m t r l the l of th th d pa (m d a l) b t the d f n s t l a d th d m e r t h m b l u (or e t f the l um) s th ne t n l n g th the c s a t te m i s a t th ne t n l n g th t h l e l f the gladi l th d a m t at the m b l u s c m g th l

With the 3 exceptions noted the second shortest anteroposterior diameter of the trunk proper is at the level of the third space midaxial (about the level of the apex of the axilla) From this level the anteroposterior diameter tends to increase in depth rather steadily toward the level of the gladiolus it then remains about the same or slightly decreases to the level of the ninth costal cartilage (costal margin) and then decrease more rapidly to its minimum depth at the level of the umbilicus (or crest of the ilium)

I 7 f the c s a t t r m d n f the s f tal c s (o- n xx n 9 vii 9 vii 9 vii 9 xxv 9 xxvi 6 xiv 6 xv) the d p a t a p te d a m t t h l l f th gladi l t t m d f t l t i the l l f th nth nb (9 t 6-xx 5 vi) n t t m t t th l l f th n th costal c t l (9-iv 9-xxvii) at t r m t f m th l l f th gladiol t th f th n th c t l c t l g (9-) a d f tal c t s f o m th l l of th gladi l t th t of th nth nb (7 xviii)

TABLE II d—FETAL CASES

Fetal trunk heights from symphysis as

	7 XVIII	6-IX	6-IX	6-IX	4 cases	5 X	VI
Case	7	58	8	07	6	71	3
Vertex	46	00	3	06	06	87	53
Costal arch		65	8	77	7	64	38
Gladiolus			5	4		5	4
Ninth costal cartilage	74	4	5	4	6	5	
Umbilicus	9		6	33	6	7	
Symphysis							
Fetal trunk heights from level of							
sternum							
Gladiolus	4	58	5		8	8	60
Ninth costal cartilage	35	35	3	0	3	1	5
Umbilicus	37	4	0	0	7	0	4
Symphysis	45		0	5	6	3	3
	9		0	33	6	7	

On the other hand in every case the transverse diameter is shortest at the level of the third space midaxial. From this level it increases steadily down to the level of the ninth costal cartilage (costal margin) and then decreases rather gradually but not to a very marked extent to the level of the umbilicus or perhaps to that of the crest of the ilium midaxial—the diameter at the latter level being the same as at the umbilicus or varying a trifle more or less.

In the 11 cases at term and in the 5 fetal cases the average increase in the transverse diameter from the level of the third space midaxial to that of the ninth costal cartilage (costal margin) is 21 and 15 millimeters respectively and in 10 of the 11 cases at term and in the 5 fetal cases the average decrease from the level of the ninth costal cartilage to that of the umbilicus is 11 and 9 millimeters respectively and the eleventh case at term shows an increase of millimeters.

Thus both anteroposterior and transverse diameters of the trunk increase from the neighborhood of the level of the third space midaxial to that of the gladiolus the anteroposterior then ceasing to increase the transverse continuing to increase to the neighborhood of the level of the ninth costal cartilage from this point downward both decrease the anteroposterior more rapidly and definitely.

Indices of the transverse planes of the trunk. The index of a given trunk plane (Table III) is obtained by multiplying the anteroposterior diameter by 100 and dividing the product by the transverse diameter.

$$\text{Anteroposterior diameter} \times 100$$

$$\text{Transverse diameter}$$

The more nearly the two diameters approach each other in length the more nearly the index of the trunk plane will approach 100. The less the transverse diameter predominates over

the anteroposterior diameter the higher the index the more the transverse diameter predominates over the anteroposterior diameter the lower the index.

A study of Table III shows that in all the prenatal cases as far back as the sixth month the index tends to be highest at the level of the third space midaxial (7 of 11 cases at term 4 fetal cases) and that thence downward it steadily diminishes reaching its minimum at the level of the crest of the ilium midaxial or of the umbilicus or occasionally of the ninth costal cartilage.

In 4 of the 11 cases at term there is a slight rise in the index as the gladiolus is reached the steady decrease beginning at the latter level (9-IV 9-VI 9-IX 9-XV). In these cases although the transverse diameter follows the rule by increasing there is a disproportionate increase in the anteroposterior diameter hence the higher index. In the case at the fifth month the usual diminution in indices occurs until the umbilicus is reached there the transverse diameter narrows to the depth of the anteroposterior diameter giving an increased index (100).

Relation between diameters and indices of transverse trunk planes. Remembering that the index of a trunk plane becomes lower in proportion as the transverse diameter predominates over the anteroposterior diameter one must be on guard and recognize that the trunk plane having the lowest index does not necessarily correspond with the trunk plane having the longest transverse or the shortest anteroposterior diameter. The diameters express the absolute distances the indices express the proportional relation of these diameters hence a trunk plane having a longer transverse diameter may have the latter so modified by a deeper anteroposterior diameter that its index may be raised. Consequently Tables II and III do not contradict each other but the predominating

TABLE III—INDICES OF THE TRANSVERSE PLANES OF THE TRUNK ARRANGED IN THE ORDER OF THE VERTICAL HEIGHTS AS IN TABLE I

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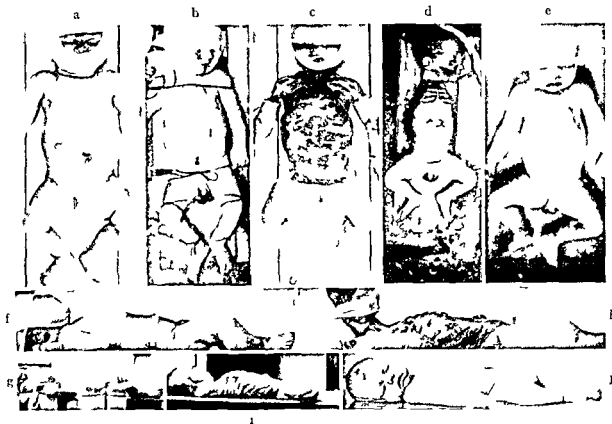


Fig 3 a b Shape of the trunk at term in the supine position anterior view seen from above (9 LIN 9 LVI) c Another subject (9 LXXIII) same position and view as in a and b with the skin and superficial fascia removed from the trunk shoulders and neck d Another subject (9 XXXIX) similar to 3 c but with the shoulder girdle and some of the external muscles removed

e Another subject (9 LIN) similar outline of 3 d with the shoulder girdle in place f Same subject as in 3 a (9 LIN) but profile view front and back profiles of the trunk in the supine position g Same subject as in 3 b same view as in 3 f h Same subject as in 3 c profile view i Same subject as in 3 d profile view j Same subject as in 3 e (9 LIN) profile view

hood of 90 degrees sometimes less (45 60 degrees etc) sometimes more

The leg and foot follow the thigh in its outward rotation so that they tend to rest on their outer surfaces the calf is broad and the crest of the tibia looks forward and outward and more or less downward the feet lying on the outer border or even partly on the dorsum The flexion of the knees carries the feet toward the middle line of the body the soles looking more or less medially The heels approximate and the feet diverge downward and outward sometimes also forward from the heel Sometimes the two sole approximate throughout their length Sometimes the feet lie one crossed above the other one sole as if clasping the opposite tibia

This position of flexion abduction and outward rotation which the lower extremities spontaneously assume is the remnant of older biologic positions which are now and

which have been throughout prenatal life in transition toward the human type postnatal position of extension adduction and inward rotation so that the patellae and feet look forward (Compare with Fig c and d)

The feet tend toward supination the soles looking a little upward sometimes markedly so The heels are small and pointed and covered with a fat cushion the ball of the foot is broad and unless obscured by fat cushions the longitudinal and transverse (anterior) arches are definite The instep is broad but the ball and toes are still broader The toes lie side by side not encroaching upon each other the great toe tending to be more markedly separate from its adjacent neighbor (Fig g to i Fig 3 j Fig 4 e) The toes are usually slightly flexed especially the middle and distal phalanges Sometimes to flexion of the middle and terminal phalanx is added extension of the first or proximal

b



Fig 4 S m b j t l 3 th p p
t p t f m b e 4 b S m b j t
l f 3 m d f m th t k h l d d c k
N t h m l f th py m d l m f f t (p
d) f m th l f t t t l d th q t
f the l p l f th tru k (l un) th t d
l b d f th g h t l f m th f c t h w
l y th p l c m t f th f t t y p l th t s d S me
b j c t F g 3 d m a 4 b th th h l d r
k d l t l d p t l y d th t l m c l e
m d N t th n f th p t p l n d
t f d l t f th s t t d f t l p l
l l p d l l t o d t f p d f m
f l p d f th p l a d S m b j c t 4
l t p f l f t d l k p f l f th tru k the
p p s t n S m b j t a 4 b p f l

Th d g f p t d th p e s e f th l
t l l t b t d m t t d b v l th l
t m t th t l l m g t d p p m t
th t b d f th l f th f t th y l - p o
t h h m t m m d p o t c o l y (f
l b)

The longitudinal arch is reflected upon the dorsum of the foot which toward the inner half is elevated proportionately the dorsum falling toward the outer half as the arch disappears and the sole descends to the plane of the heel and forefoot

When the anterior arch is marked the first phalanges continue the distally declining

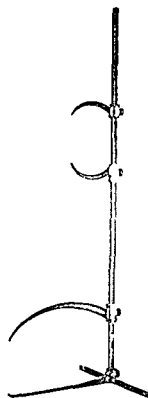
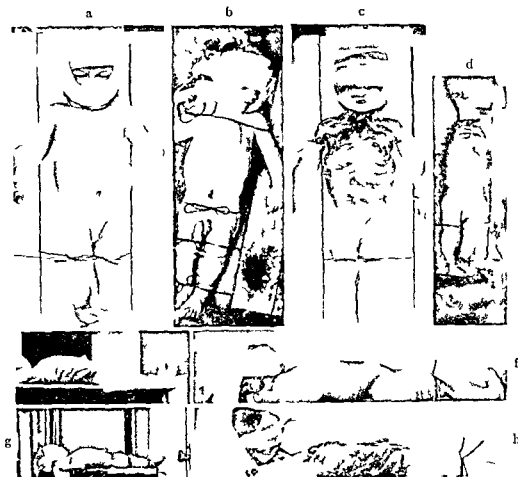


Fig 5 C l p f m f t l tru k h l t
d tru k d a m t l g t h t l d d l y th
w t d d l p e d b y G l l m C N X k
9 4

oblique line of the dorsum of the foot and continue the line of the metatarsal gradually moving toward the plantar flexion of the more distal phalanges (Fig h—left foot i—both feet Fig 3 b—both feet d—right foot f—right foot g—right foot) When the anterior arch is less marked the distally declining oblique line of the dorsum of the foot is broken at the metatarsophalangeal junction by an angle opening dorsally the first phalange moving toward dorsal flexion with lowering of their proximal ends. The distal ends of these first phalanges thus project upward and the palmar flexion of the more distal phalanges continuing the appearance of claw or hammer toes is thus produced (Fig b—left foot g—both feet h—right foot Fig 3 a—right foot) This variability suggests that the anterior arch is not definitely fixed at term and that it depend upon free

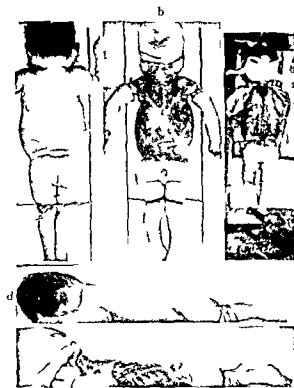


16 a Same subject as in Figure 3 a and same position but with the lower extremities extended adducted and rotated inward so that the patellae look forward. Note the strong action to adduction and supination of the feet due to the tension of the thighs and knees. The thighs are tied in a slightly exaggerated inward rotation to counteract the strong pull of the deep fibrous tissues toward flexion abduction and outward rotation. Note the greater firmness of the contracted fibrous tissues in the right extremity causing shortening of that extremity from persistent flexion at the hip and knee. b Same subject as in Figure 3 b and same position but with the lower extremities extended adducted and rotated inward so that the patellae look forward. All of these changes being less complete than in 6 a. Note the beginning interference of the forepart of the feet with each other, both extremities being about the same length. c Same subject as in Figure 3 c and same position but with the lower extremities extended adducted and rotated inward so that the patellae look forward. Note the narrowing of the trunk from side to side and the descent of the symphysis. d Same subject as in Figure 3 d and same position but with the lower extremities extended adducted and rotated inward so that the patellae look forward. Note the sharp flattening of the lateral planes as

they pass backward from their junction with the anterior plane. e Same subject as in Figure 3 e and same position but with the lower extremities extended adducted and rotated inward so that the patellae look forward. Note the forward and downward rotation of the pelvis, the forward arching of the lumbosacral region (posterior abdominal wall), the forward projection of the anterior wall of the whole trunk, the upward and forward rotation of the thoracic cage, and the lengthening of the abdomen anteriorly. f Same subject as in 6 a and same position but viewed in profile. Compare with Figure 3 f. The forward arching of the lumbosacral region is shown more clearly than in the preceding case. g Same subject as in 6 b and same position but viewed in profile. Compare with Figure 3 g. The tying of the lower extremities has relaxed somewhat allowing the firm fibrous tissues to draw the extremities toward their former out and rotation as shown in the patellae and feet. h Same subject as in 6 c and same position but viewed in profile. Compare with Figure 3 h. As in the preceding case, the tying has relaxed somewhat and the continual action of the deep fibrous tissues has drawn the right lower extremity toward its former out and rotation as shown in the position of the patella and foot.

plantar flexion of the metatarsophalangeal articulations and the preservation of the grasping powers of the whole forefoot (Figure 1 compare with subhuman forms—Figure c d e f).

The inner border of the foot forms a very obtuse angle opening inward (medial) and a little forward at about the level of the scaphoid or a little anterior to this bone. The first metatarsal bone and the great toe form



I k 7 a s m t j t a i f k d d m p s t i
 (p w d f m b) but th th l w t m t
 t d i d d t d i t d r d th t h p l e
 l k f d b s a m s b j t I g 4 b d s m e
 p t b t th t h t w t e m t t n d d d t
 d t t e d d t h l t t m o m k l l y t h 6 a
 N t t h f t h e d e p b a k f t h w h l t r u k
 e s p l l y f t h l N t l o t h h a g n d e t n
 f t h u d t h e l p n s (p m) w l k
 l d d a d m e b k a d d t o t h f r a d
 d d n d t a t f t h p e l c s m b j e t s
 n l i 4 i m p t l t w i t h t h l e
 t m t t d d d d t d l t t d w d t h
 l t t l m k d l l y t h n d s m b j c t s a
 n d m p t i b t d p f l e C m p t h
 t t 4 d Th h o y l l y t h f r d d
 d n a j t t f t h p l s d t h c d n
 n t n t f t h l m b l e g a d t m k s
 p l t h h g d t f t h d p r e m s
 l l t h t d l f t h e p l N t
 d m p h d h t o f t h g h l e e t m t y e r
 t h t d t t h f l l t t h g f t h d e p
 t l t d p l d c f m t t h p t
 n t l p t s m b j t 7 b d s a m p o t
 b t d p f l C m p t h F 4 N t h
 m k d n t t y t h e o t h r a c g n d
 t o h y p t f t h h d d k

the anterior arm of the angle this anterior
 arm extending forward and still farther
 medially. The outer border of the foot forms a
 very obtuse angle opening outward at about
 the level of the cuboid. The fifth metatarsal
 bone and the fifth toe form the anterior arm

of this angle this anterior arm extending
 forward and still farther outward (Fig
 2 b g Fig 3 f g j Fig 4 c d Compare with
 Fig 2 c for a subhuman foot showing similar
 angles d e f for a subhuman foot showing
 diminution or absence of these angles and
 h i for a human foot at term showing almost
 complete obliteration of the internal angle of
 the right foot under pronation)

The femur is curved from without inward
 and from before backward the convexity
 looking forward and outward and being on
 what becomes the anterior surface when the
 bone is rotated so that the patella looks for
 ward this surface now being directed forward
 and outward

The bones of the leg are curved concave
 inward and forward the concavity being on
 what becomes the internal surface when the
 thigh is rotated so that the patella looks for
 ward this surface now being directed inward
 and forward the curve being more marked
 in the tibia than in the fibula. This curved
 line continues downward to the sole where
 the heel tends to merge into the beginning of
 the arch the line being broken only by the
 slight prominence of the internal malleolus

I t h p t f t h l g l f t d m t h e b l t h f o o t
 h g s l y t h t h l e d t h e w h t f t h f o o t u s
 t t g t o w d t h t s d f t h e l c t h t e r l
 m l l u t b t g l d t h f t t d t f l l t t a l l y
 l r d g h t g l t h t h l g a d t h p a r t f o d f
 t h n k l t o d o o p l o t h t h e h l

Changes in the lower extremities and modi
 fications of the body form occurring at term as
 the advanced postnatal position of the lower
 extremities is developed. If one attempts to
 place the flexed abducted and outwardly ro
 tated lower extremities in the postnatal po
 sition of extension adduction and inward
 rotation so that the patella look forward re
 sistance is met. If the resistance is discar
 ed it is found that the postnatal position can
 be attained only by compensatory changes in
 the pelvis abdomen spine and thorax as well
 as by direct changes in the lower extremities
 themselves (thigh leg and foot). Summarized
 these changes may be grouped as follows
 (Figs 6 and 7 compare with Figs 3 and 4)

1 The trunk thigh lateral angle increases
 toward practical disappearance and the lateral
 pelvic region becomes defined between the

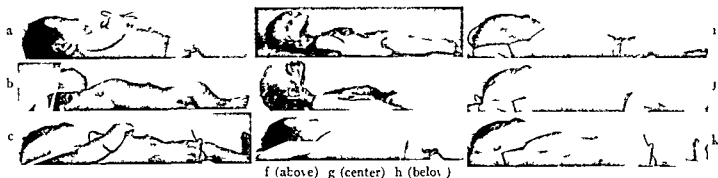
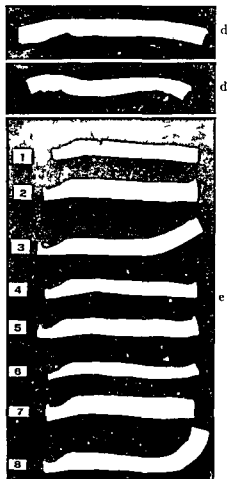


Fig. 8 The spinal curve at term. a Same subject and same position as in Figure 3 f but with the head in spontaneous flexion and with the arm drawn forward enough to show the apparent absence of anteroposterior spinal curves in the supine position at term. b Same subject and same position as in 8 a but with the head held in extension so that the face lies in the frontal plane. c Same subject and same position as in 8 b but with the lower extremities extended, adducted and rotated inward and with the arm drawn forward as in 8 d. d Posterior line of the spine in the undisturbed subject, supine position, viewed from the right. Note only the lower line of these two casts. e Plaster cast showing along its lower edge the posterior line of the spine and lower occiput in 8 b. f Plaster cast showing along its lower edge the posterior line of the spine and lower occiput in 8 c. g Anterior line of the spine after removal of all the vertebrae, supine position, viewed from the left. Note only the upper line of all these casts. h to k (9 LI), l (9 LII), m (9 LIII). n Plaster cast showing along its upper edge the anterior line of the spine when the head is flexed so that it rests on the lower part of the occipital protuberance (a trifle more flexion than in Figure 11 a, compare with Figure 11 b). o Head flexed so that the face lies in a plane which makes an angle of about 45 degrees with the horizontal plane upon which the trunk rests (Figure 11 a). p Head extended so that the face lies in the frontal plane. q Head extended so that the face lies in a plane parallel to that upon which the trunk rests a trifle more extension than in Figure 11 d. r Same extended position of the head as in q but the occiput is allowed to seek its support (13 and 35 mm. respectively) below the horizontal plane upon which the trunk rests till the occipital base of the occiput is in line with the straight cervical spine the latter resting on the same horizontal support as the trunk (Figure 11 g, h, i). f (9 LIII), g (9 LIII). Development of a cervical anterior convex curve by both flexion and extension of the head when the backward and downward curvature of the occiput is restrained by its resting upon the same horizontal plane as that upon which the trunk rests. Upward and forward rotation of the thoracic cage upon a transverse axis is caused by raising the arms so that the humerus approaches the side of the head. Same subject as in 8 a. h Same position as in a but with the arms raised to the side of the head without flexion or extension of the elbow. i Same as h but with the humerus tied in position and with the elbow tied in extension. j Same as i but with the head supported in extension so that the face lies in the frontal plane. k Same as j but with the lower extremities held in extension, adduction and inward rotation.

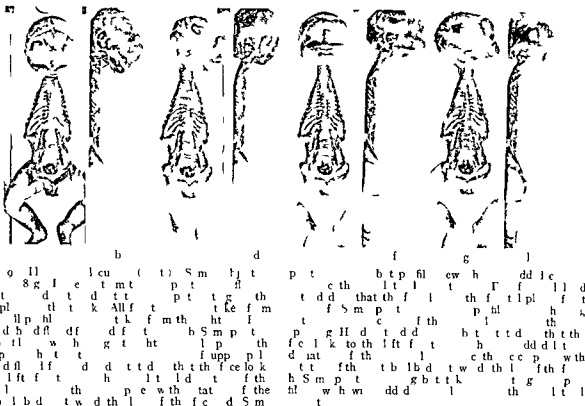


crest of the ilium and the trochanter the outer surface of the great trochanter looks backward and outward instead of backward and a depression forms behind it while the buttocks narrow and fall. The whole trunk narrows from side to side (especially the loins) and appears to elongate. Modeling of the trunk, thighs, legs and feet develops.

The anterior internal and external surfaces of the thighs become tense and depressions appear in front of behind and below the trochanter while a depressed longitudinal band of tension extends down the

outer surface of the thigh toward the knee. The adductor region is thrown into oblique grooves running downward inward and backward. The tension in the thighs is conveyed over the patella and around it on both sides to the legs (more marked on the inner sides) which now describe a slight curve with the concavity medial. There is added strong tension down the back of the thighs and legs to the heels.

The tension in the legs is conveyed over the dorsum and side of the feet which now continue the curved line of the legs and tend to



overlap. The feet follow the curve of the tibia causing the front of the feet to approach so that the first and second metatarsal bones may overlap while the internal malleoli are still separated the axis of the leg now falling toward the outer toes. The angle on the internal border of the foot becomes more rounded and its apex appears to move nearer to the ankle owing to the inward rotation and supination of the foot. For the same reason the angle on the external border rounds so that this border may tend to continue the slight externally convex line of the leg (Fig 1—the left foot Fig 6 a to f Fig 7 a b).

If th l o l f t f m th t b l t l t th
 k l b t th l l th f t d by th foot
 f t f th k l fl d d th t th l l
 pl l d d f w d Th f t
 fl l k th l b t t d t t b

2 The pelvis rotates forward and downward about a transverse axis (Fig 6 compare with Fig 5, Fig 7 compare with Fig 4) the ilia and upper part of the sacrum are carried forward and downward the lower part of the sacrum is carried backward and upward and the symphysis pubis descend. The fifth

lumbar vertebra follows the upper sacrum and the ilia and the other lumbar vertebrae and often the lower thoracic vertebrae are reluctantly dragged after the fifth forming an anterior convex curve deepest at the point of firmest union and greatest stress and decreasing upward as the mobility of the vertebrae increases and as the stress decreases. The supine pelvis now rests on a lower portion of the posterior plane than when the thighs are in spontaneous flexion. For instance resting upon the lower sacrum when the thighs are in spontaneous flexion it would rest upon the junction of the sacrum and coccyx when the thighs are extended (Compare Fig 1 b d f h with Fig 9 b d f h).

3 This changed position of the lower extremities the pelvis and the lumboacromi thoracic spine causes a marked change in the abdomen and its viscera and in the thoracic cage. The abdominal cavity is contracted from behind forward by the throwing forward of the lumbosacrothoracic and the upper iliac regions and it appears narrowed from side to side especially in the region of the loin.

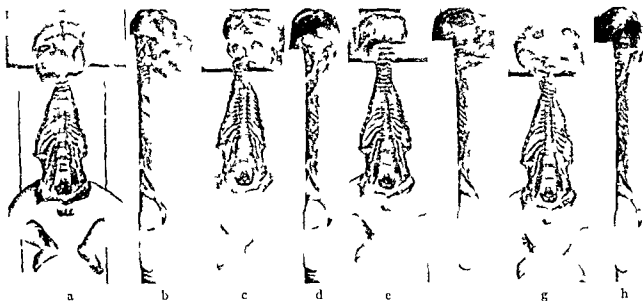


FIG. 10. The straight cervical spine. (a) to (h) Same subject and same position as in Figure 9 except that the occiput is unrestrained in both flexion and extension of the head and is allowed to seek its normal positions dorsal to the straight cervical spine coming to rest on a horizontal

plane which is lower (dorsal) than that upon which the trunk rests but parallel to it. Note the absence of the cervical lateral curvature when the head is rotated to one or the other side though the lateral deviation appears but to a lessened extent.

The pelvis no longer looks like the upward expansion of the lower extremities united with the trunk at the trunk thigh lateral angle. It now appears like the lower portion of the trunk of which latter the lower extremities appear to be direct downward continuations. It lies more obliquely between the trunk and the lower extremities the latter now lying in a plane the long axis of which continues the long axis of the trunk. As a result of this changed position the viscera no longer rest so completely upon the broader back and within the upper pelvis but are thrown forward and downward causing increased stress on the anterior and anterolateral walls which are lengthened by the descent of the symphysis (Fig. 6 compare with Fig. 3) while the back appears shortened by the increased lumbosacral angulation (Fig. 7 compare with Fig. 4).

4. In proportion as the tension from the anterior convexity of the lumbosacral region extends upward into the thoracic region the thoracic cage tends to be rotated upward and forward again causing lengthening of the abdomen anteriorly.

These changes in body form cause some variations in the trunk measurements. Attempts were made to resolve these complex changes into their simpler elements so note

was made of the details observed when in its spontaneous position no change was made except to rotate the thigh inward or to adduct it or to extend it or to extend the knee in the varying positions of the thigh.

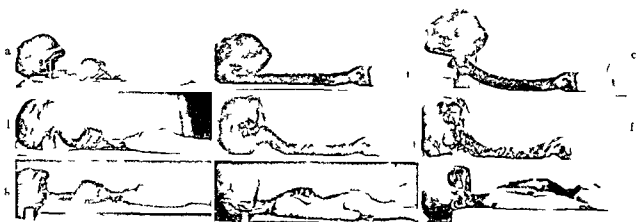
Thus inward rotation of the thigh can be accomplished as an isolated action when the thigh is left in its original flexion and abduction (b). But a adduction of the thighs so that the knees approach each other and the patellae look forward cannot be accomplished as an isolated action this movement being always accompanied synchronously by inward (for add) rotation (c). The thigh can be adducted with a minimum of inward rotation if the knees are allowed to overlap the flexion of the overlapping thigh being then increased.

Extension of the thigh on the pelvis can be accomplished in both the abducted (d) and adducted (e) positions this action always being accompanied by less (d) or more (e) for ward and downward rotation of the pelvis upon a transverse axis and by a bending extension of the leg at the knee—this latter movement tending to the foot and in its most complete form causing inward rotation of the leg and foot with supination and adduction and with overlapping of the fore part of the feet.

Extension of the leg, on the thigh can be accomplished in both the abducted (a) and adducted (f) positions of the thigh and in both positions the action is carried upward to the thigh and pelvis and downward to the leg and foot.

Leaving the thigh flexed abducted and rotated outward and making no change in the original spontaneous position except to extend the leg, on the thigh at the knee.

Tension and rigidity develop in the popliteal space along the posterior internal thigh alone the anterior internal thigh to below the symphysis pubis and along the tendo Achillis. The resistance offered can apparently be overcome only by making tension and stretching the hamstring tendons especially the internal going to the tibia and to a less extent the adductor mass.



b (t) (te) h (b l)

F Th t ht dtl d cl p th t th l p Th fle f th c th ac c
 dd d d m t t of th l m l nte o e sp b g th o put fa f t f th l mb tho c
 (9 LI) Lo t m t fl d bd t d d p hil th f l n obl q pl e form
 t t d t ad H d fl d th t th pl f th f c gl f h l t 6 d th th ho t l pl e p
 f l p h h t t k t p t t g th wh h th l two th d f th t k t d S m
 m j l th t k p fl f t ght s bje t a b th ade t d d th t th f l
 p th h t t a e c at th pp p l b t th f r l pl e p file w of ce c l te
 (mp th l 8 d 6) b S m b j t F b j ct b dc l t ml t th t db t th
 9 H d fl d l t l m th b th th lo e t m t the pel d th l mb ral
 t t l s d) Lo t m t d nd d dd ted b th p t t d d l l dt k t
 a l t t d w d d l p f d d d d m l p st d ad to th p m t et h
 t t f th p l d a th l m l l tal p wh ch l (d sad) th t pon h ch
 t e f th l d pp thorac th trunk st b tp ll t t p fl w f th taght
 p th t f th h ad th oc p t b l p n (c mp w th F 1 8 e 4 d 5) h S m
 t i d ll f t k t mal p t d d b j ct F g 8 f P t m la t th t g S m
 b j ct b e f (9 LXIII) P t m l t g

Th m v b l htf l d w d t t f th t ha t a d a b d l f te n b t the e t
 p l th m d a d m t m l htf l d f th l m d th k e th f m f a b d hall w
 d t t f th pp t de f th p l d th g d w th t de f th th h (Comp F g
 l t t m m t m y b y d l d l th w th F g 4)
 pp t l t m ty th l t t t sl htv Th l t a p l c g i no d f l bet th t
 th h l th d t ty t th t th th l m d th t h t by th l f t pw d f the
 t p p f th l m th k d th t s ft t d m k t the f m fib t
 d b l t th l p t po t f the f d at d Th i a q e t f te l th d p
 l w t m t d m k ch pt t t t f f th b k a d de b the c t f the l m
 th th h d d f th t f th bd m n bet the m l d the
 Th m m t f th p l t l th p l l ymphy p b
 Th b t h d th l u p t bo tt ad
 th p f th p b f th s m d th pel b g st
 tate f r d ad t th opp t d I add t g the l e t m t th y l po t
 t d tat th h l m t f st I dd t th m w th w d t t o th t th pat l l t r
 th te p t f th f e t m t f t d ! p the f t te d g t f flow d p l g th t l c r ve
 f th leg f th i d w f th f e t p ted by th m g t t f th t l bo d rs f th f t
 th y ed t d f d th b m g p t t d off a d d w d N t c l l th gh t
 c t f th p t l l t d f l l th gh th l f th th d c d te l tw th t (F g 6 b)
 C m pl t dd ct f th l t m t ppos d m h lly by th l g d d t m d th f t
 t which p trud a d p es th t l g t l

by the relatively great breadth of the latter and by the apposition and tendency of the feet to overlap

d Restoring the original position and making no change except to extend the thighs on the pelvis letting the legs fall over the edge of the table

Tension develops throughout the length of the thigh. The pelvis rotates forward and downward with arching forward of the lumbar spine and lifting forward off the table of the posterior loins. This action is more pronounced when extension of the leg precedes that of the thigh. The arching of the trunk is about one third as much as when adduction and forward rotation of the thighs are added.

Tension from the thigh is conveyed over the patella and around it on both sides to the leg causing springing forward of the leg in slight tension (similar to the patella reflex response) with increased tension over the front and side of the leg and suggestion of the same tension even posteriorly also the same over the dorsum and sides of the foot.

e Combining c and d—adducting and rotating forward the thighs and then extending the thighs on the pelvis but leaving the knees flexed by letting the legs fall over the edge of the table all the preceding phenomena develop in a more definite form.

The pelvis is at once rotated forward and downward on a transverse axis the lumbar spine and loins following it. Tension develops over the anterior internal and external surfaces of the thighs with deepening and broadening of the external longitudinal shallow groove the tension extends upward to the trochanter to the anterior superior spine and to below the crest of the ilium also along the trunk fascia especially laterally between the crest of the ilium and the ribs and through the abdominal wall strong tension is felt along the psoas iliacus. The lower thoracic spine follows the forward arching of the lumbar spine with rotation upward and forward of the thoracic cage causing lengthening of the distance between the gladiolus and the symphysis pubis with rounded prominence and increased tension of the whole anterior abdominal wall.

When the movement of the upper trunk is inhibited (as by its stability or by holding it) tension in the posterior loins is increased when there is lessened resistance in the upper trunk the posterior arching is increased and diffused cephalad as above the upper trunk sliding downward as the thoracic cage arches forward and upward.

The tension on the thighs is conveyed over the patella and around it on both sides to the legs and feet as described but more markedly. The foot continues the line of the leg which describes a slight curve the concavity being directed medially.

f Adduction extension of the knees to the preceding adduction for rotation and extension of the thighs all the preceding lines of tension and movement are increased in intensity as already described in the advanced postnatal position of the lower extremities.

The longitudinal groove lengthens and becomes more strongly marked sometime it tends to become oblique from the neighborhood of the ante or superior spine towards the head of the femur. There is added strong tension down the back of the thigh and leg to the heel also on both sides of the tibia more marked on the inner side and causing slight movement toward flexion and supination of the foot which is held firmly in the continuation of the curved line of the leg already caused by adduction and inward rotation of the thighs so that at the most distal portions of the feet are directed the most internal and the frontal portions of the feet tend to overlap.

When this overlapping is prevented and the heels are kept approximated there occurs a proportionate amount of abduction with the inversion of the feet. This can be com-

pensated for by increased inward rotation of the thighs separating the heels and abducting them allowing the frontal portions of the feet to curve inward.

The tension along the legs is not only increased but the feet are carried more firmly inward at the malleoli and the forward part of the feet tend more decidedly to overlap. If this overlapping is prevented whichever foot presses the more strongly forces the other into corresponding outward rotation (pronation abduction with slight inversion).

Both of the legs extend even when adduction and forward rotation are complete because of the curving of the bones of the leg in internal concavity. When adduction and inward rotation are incomplete the bowing is continued upward to the thigh though sometimes broken by the inward projection at the knees (Fig. 6 b Fig. 7 c). A condition of knock knees is produced or favored when the legs do not follow the thighs in adduction this failure is caused by incomplete locking of the knee joint due to incomplete tension of the leg on the thigh (Fig. 6 a Fig. 7 b).

THE ANATOMICAL FACTS ALONG WHICH THE POSTNATAL BODY FORM IS DEVELOPED FROM THE BODY FORM AT TERM

As all the muscles in the dead body are lax and non contractile all the shapes positions actions and movements described must be due (aside from the mechanical presence of the muscle masses the fat masses and the viscera) to the arrangement and connections of the firm fibrous tissues. These tissues are the bones ligaments around and within the bony articulations the deep fasciae intermuscular septa muscle sheaths tendons and aponeuroses and to some degree the superficial fascia and the skin. Nerve sheaths are shown to be very important so are arteries and veins which run a straight course while vessels which run a tortuous course can as a rule be disregarded probably because the tortuous course does not convey tension as does the straight course. All these tissues must in the light of the experiments here made be considered as being the more fixed and conservative factors in determining and preserving the body form. The position spontaneously assumed by the child at term is due to relative shortness of the firm fibrous tissues along lines made strong by older biologic paths and this explains the anatomical difficulties which beset the struggle toward the biologically more recent human type and the tendency of the latter to spontaneous reversion toward details of the earlier prenatal type.

Hence modifications of the body form are essentially due to modifications of these fibrous tissues. And the postnatal changes in the body form are essentially due to certain definite stretchings and tractions of the fibrous tissues (plus contour and other modifications due to positions and conditions of the viscera and to muscle and fat masses) and to the activity of the muscles, these latter being the agents which are continually antagonizing the innate tendency of the fibrous tissues to return toward their earlier relations. In other words the instinct toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera), the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera). And whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly, movement then being in the direction of reversion toward earlier (prenatal) forms.

It is manifest that the tendency toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera), the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera). And whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly, movement then being in the direction of reversion toward earlier (prenatal) forms.

Attempting at term to trace the anatomical paths and relations along and through which these fibrous tissues act, one notes that on continuing the external force necessary to change the lower extremities from their spontaneous position of flexion, abduction and outward rotation to the postnatal position of extension, adduction and inward rotation, both the thighs and the legs tend to return to their former spontaneous positions, this return being diminished in proportion as the tissues have been stretched beyond certain limits.

It is manifest that the tendency toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera), the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera). And whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly, movement then being in the direction of reversion toward earlier (prenatal) forms.

Skin and superficial fascia. The relation of the skin and superficial fascia to details of the

body form is shown in the surface markings and in the modifications of these markings which appear with changes of positions and upon removal of these tissues in the laxity and change of contour seen in those muscles which have no or only thin fibrous coverings.

Deep fibrous tissues, nerves, blood vessels. *pelvis, thigh, angle, pelvis, spine, union.* After the removal of the skin and superficial fascia the deep fibrous tissues are exposed and their traction and stretching and overstretching may be observed directly. One may see these tissues stretch, grow tense, grow rigid, the arteries elongate and flatten, the blood become pressed out from the stretched and collapsing veins, the nerve trunks grow taut, the fibrous planes develop pale, thin and flaccid areas and finally shred into solution of continuity according to the degree of antagonizing external force applied.

The tendency toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera), the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera). And whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly, movement then being in the direction of reversion toward earlier (prenatal) forms.

Incisions were made across the fibrous tissues which offered resistance to the development of the postnatal position of the lower extremities. The results of these incisions justify the following deductions:

1. Flexion, abduction and outward rotation of the lower extremities are due to shortening of the deep fibrous tissues of the anterior, internal and external regions of the thigh and to some extent of those of the posterior part of the thigh, including those of the great sciatic nerve, and also to connections of the fibrous tissues with the hip joint, the pelvis and the lumbar spine.

Abduction and outward rotation of the thigh depend not only on the relative shortness of the fibrous tissues already enumerated

but also on the formation of the capsule of the hip joint and its spontaneous tendency to untwist and assume a direction favoring outward rotation of the femur with abduction.

3 Adduction and forward rotation of the thigh in the plane of the spontaneous flexion present lock the hip joint and make the pelvis and femur practically one bone bent at an angle opening forward and united by the shortened and thickened capsule. The size of the angle depends on the degree of spontaneous flexion present. As a result of the development of this pelvic thigh bone backward movement of its lower end (extension of the thigh) causes forward movement of its upper end (forward rotation of the pelvis). Associated forward passing of the lumbar and lumbosacral spine follows according to the firmness of connection of the pelvis with these vertebrae. But while the upper lumbar vertebrae are progressively freed from the forward pull of the (pelvic) fifth lumbar vertebra they continue to be pulled in the same anterior direction by their direct attachment to the upper end of the femur through the psoas iliacus muscle. When the pelvic thigh connection is established the only movements possible in the hip joint are a certain amount of abduction and a very slight increase in adduction. Weakness of the locking of the hip joint probably enters first through abduction since that is less opposed than adduction.

4 Extension of the thigh favors extension of the knee, the impulse being conveyed down the leg to the foot.

5 Adduction and supination of the feet are directly related to extension, adduction and forward rotation of the thigh and extension of the knee by the deep fibrous tissues. When the knee is not fully extended locking of the foot in adduction and supination is diminished; abduction and pronation are favored and these movements of the foot may lead to outward rotation of the leg and thigh with or without torsion of the knee from within outward with prominence of the internal condyle of the femur.

6 Extension, adduction and forward rotation of the thigh must be accomplished by some active force not present in the dead

body. Since there is no tissue which acts spontaneously and continuously in the direction of extension, adduction and forward rotation as the fibrous tissue does in the direction of flexion, abduction and outward rotation, whenever the active counteracting but intermittent force (muscle) relaxes the former tendency asserts itself and draws the thigh towards flexion, abduction and outward rotation.

Dissections. Group a. Thigh hip joint pelvis lumbosacral spine thoracic cage.

a1 Incision in the upper portion of the thigh and blunt dissection to expose the capsule of the hip joint, thorough incision of the capsule including both limbs of the Y ligament. Then adducting, rotating inward and fully extending the thigh, the head of the femur protrudes beyond the limit of the capsule.

The lumbar spine, the loins and the pelvis still move forward on extension of the thigh, though less extensively and with less force. All of the muscles of the anterior and anterolateral parts of the thigh are made tense by the extension, especially the tensor vaginae and the sartorius but also the rectus and also the adductor region (gracilis?).

Extension also causes grooving of the surface of the thigh distally upward from the outer side of the knee to over the tensor vaginae. A second groove or depression appears in front of and below the trochanter.

a2 As the skin and superficial fascia are removed one notes that there is some relaxation of the deeper tissues. The adductor mass on the inner and posterior sides of the thigh is not being confined by the deep fascia; falls lax. The quadriceps femoris, tensor vaginae and gluteus medius are firmer. The gluteus maximus is midway between the other two groups in firmness. The leg muscles, especially those on the outer and outer and posterior surfaces are held firmly by the deep fascia.

a3 When adduction is added to inward rotation of the thigh in the plane of the original flexion, there is tension on the fascia lata, especially in a grooved band which is formed in front of the great trochanter and behind the tensor vaginae running thence upward and backward while a second is formed running downward to the external condyle of the femur if not to the external tuberosity of the tibia (Fig. 4 a).

a4 Tension of the lower extremities now causes diminished forward rotation of the pelvis, apparently from diminished size of the fulcrum of the thighs and buttocks due to the removal of the mass of fat over the latter, when this deficiency is supplied mechanically, as by interposing a hand, the rotation appears to be the same as at first.

a5 When the knee is extended in the plane of the spontaneous position of the thigh, there is resulting tension on the adductor mass and on both hamstrings when the thighs are first adducted, the knee is tensed only in the outer hamstring.

a6 When the lower extremities are adducted and rotated inward, extension at the knee is favored by outward rotation of the leg at the knee, then forward rotation of the pelvis, the leg mark.

a7 In each of the thigh flexed, adducted and rotated inward and outward, extension of the leg at the knee (compare with Fig. 15 d) the line of tension disappears (compare with Fig. 15 e) except that it remains much diminished in front of the upper part of the trochanter and extending upward and backward from there. Tension is now visible

and producing grooving below and in front of the internal malleolus and still more marked behind the malleolus it also produces tension on the scaphoid and on the sole of the foot below the bone and along the metatarsal bone.

b₂ The foot continues the line of the leg which describes a slight curve, the concavity being directed medially. The inner edge of the foot forms an angle opening inward at about the level of the scaphoid, or a little anterior to this bone. The first metatarsal bone and the great toe form the anterior limb of this angle, this anterior limb extends forward and still farther medially. When the knee is extended and the fascia of the leg made tense, this position of the foot is more firmly maintained.

b₃ When the knee is relaxed and flexed and the forward part of the foot is taken hold of this latter can be moved laterally toward the ankle, both directly and with some rotation; a similar rotation can also be developed in this region by grasping the heel from the sole. When the knee is extended these motions are much restricted.

b₄ The tension which extends down along the outer side of the leg when the knee is extended passes to the external malleolus thence to the sole and also to the dorsum of the foot especially opposite the last four toes; this last tension is best felt when making slight counter pressure against the dorsum of these toes. The tension is also conveyed behind the external malleolus which is drawn slightly upward and forward, the whole leg seeming to rotate inward. The same tension appears to exist on the posterior surface of the leg.

b₅ The heel was originally on a higher plane than the front of the foot. Bringing the forefoot up into the same plane as the heel makes the tendo achillis tense especially toward the inner head of the gastrocnemius which latter appears to become displaced toward the antero-internal side (tension in fascia). It is easier to evert the foot after cutting the tendo achillis, not direct eversion but the heel rotates forward and inward.

b₆ When in the original position of flexion the thighs are adducted and rotated inward, both legs and feet are held in the same relative position. The crest of the tibia looks inward and a little forward. Without changing the position of the thighs, the crest of the tibia can be brought directly forward only by outward rotation of the leg at the knee. Extension at the knee is favored by outward rotation of the leg at the knee, then for inward rotation of the pelvis is less marked.

b₇ When the thighs are adducted and rotated inward the foot looks inward and a little forward; if held so the foot can be brought directly forward by slight rotation but it can not be adducted so that the toes are directed forward and outward without being also everted.

b₈ If the leg is rotated at the knee so that the crest of the tibia looks forward, the foot can be adducted slightly (10 degrees or less) without eversion. This is about the usual relation between the axes with reference to the axis of the crest of the tibia which is directed inward to the axis of the foot and if prolonged would terminate about the tarsometatarsal joint. To bring the foot into the axis of the tibia, the toes must be turned in.

b₉ When the lower extremity is extended adducted and rotated inward so that the patella looks forward the foot curves so as to continue the internal concavity of the leg, the ends of the toes lying in an oblique line, the end of the great toe being the most distal.

b₁₀ After the hamstring muscles are incised the leg tends more to rotate outward at the knee. After all the muscles below the knee are incised also the vessels and nerves including also all the deep and superficial fascia except such as keep the knee joint intact, the knee still reverts spontaneously to flexion (a24).

From the dissections noted it might appear that the close union of the pelvis and the femur at term is due to limitations present in the capsule of the hip joint. But it will be noted that these dissections were made by examining the hip joint with the fibrous tissues of the pelvis and of the thigh more or less intact. It will also be noted that as the fibrous tissues of the thigh are incised the action of this region upon the pelvis becomes progressively lessened (a15).

In another series of dissections by means of fractional circular incisions of the thigh from the knee upward extending inward to the femur the pelvis and the capsule of the hip joint were freed from the action of all connections with the firm fibrous tissues of the thigh and it was then found that the head of the femur moved freely within the capsule without affecting the pelvis. Hence the inference appears justified that the pelvis is acted upon as above by the femur because of firm fibrous tissue connections between the pelvis and the femur and between both of these and the capsule of the hip joint.

Thus this study shows that through its firm fibrous tissue connections the thigh exerts a powerful influence upon the body form—as far caudad as the feet and toes and as far cephalad as the abdomen and thorax. Its influence caudad is seen to be exerted through the direct continuity of its fibrous tissues—not only those related to the deep fasciae and the muscles but also those of the great nerve trunks and affecting markedly the bones and the articulations.

Its influence cephalad is more complex. The continuity of its firm fibrous tissues is less simple and its influence is exerted more directly upon and through two other complex structures—the pelvis and the lumbar spine (both singly and in combination) and thence to the lower thoracic vertebrae and the thoracic cage and through this latter to the cervicothoracic vertebrae and the head. We are thus led to the study of these more cephalad structures.

THE ANTEROPOSTERIOR SPINAL CURVES

Four anteroposterior spinal curves are developed in the supine position at birth—

cervical and lumbosacral anterior convexities and thoracic and sacrococcygeal interior concavities. Of these four curves two are organic (the lumbo sacral and the sacrococcygeal) and two are functional (the cervical and the thoracic) (Fig 8 d i e, 8 Fig 11 e f).

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 p a l l) with th t p n w h t t n k t (F g 8b)
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 p t f t h s p i l n t h e b a k b g n n g a u d h o w
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t l a y g t n h l d p n c n d b d f f f p l a t f
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 m k s s f r m n e d t e n s o n d p s u r (l s
 d c m p t h l u f)

The cervical spine—curved and straight
spontaneous tendency toward flexion of the
head and neck When the head of the child is
 unsupported it yield to gravity and falls
 freely either forward or backward and less
 freely to one or the other side These bend-
 ing movements take place not between the
 head and the spine but in the cervical verte-
 bræ the only direct movements of the head
 on the latter being the slight nodding move-
 ment of the occipital condyles on the articular
 masses of the atlas In all other movements
 one or more of the cervical vertebræ move
 with the head The forward and backward
 bending movements may be direct but they
 tend to be accompanied by a lateral move-

ment which adds more or less lateral rotation of the cervical vertebrae.

In the supine position with the occiput resting on the same horizontal plane as the trunk the head spontaneously assumes a position of more or less flexion the chin tending to come to rest more or less above the level of the sternal notch. When the face is held anterior the head in this position rests upon the lower part of the occipital protuberance. But it can not balance spontaneously upon this small point so when support is removed it tends to rotate laterally (the face looking more and more outward as well as forward and a little downward) to one or the other side tending to come to rest on the occipitoparietal lateral junction on the occipitoparietotemporal junction or even on the lateral surface of the parietal bone above the temporoparietal junction (Fig. 2 a b h Fig. 3 b e i j).

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b e f th o p t nd f the tho a ; teb æ r e p c
t l y (F g 8 f)

Development of cervical anterior convexities with or without lateral deviation and with or without lateral curvature As soon as the child is born and falls supine upon a resisting surface whether the head falls into spontaneous flexion or is more or less extended it tends to develop a cervical curve the convexity of which is anterior and also a little toward one or the other side with some rotation of the vertebral bodies toward the line of the face

When the head falls in spontaneous flexion with the occiput resting upon the same

supporting plane as the trunk palpation reveals a slight high anterior cervical convexity (similar to Fig 8 f) with convexity perhaps increasing somewhat and adding a lateral deviation as the flexed head falls side ways (Compare with Fig 9 i b c d)

If now the head is extended so that the face moves into a plane parallel with the horizontal plane upon which the trunk rests one notes a developing tension of the soft tissues on all sides of the neck which latter narrows and elongates this tension leading towards upward and forward traction upon the front of the thorax. The tension and traction are exerted upon the thorax both directly and indirectly the latter through the medium of the anterior portion of the shoulder girdle the clavicle (Fig 3 f g Fig 8 compare a and b). Palpation now reveals a more marked anterior cervical convexity which extends lower down towards the thoracic region.

A lateral deviation is added if the head is rotated to one or the other side. This lateral deviation may extend downward through the cervical region and involve the cervicothoracic junction or even the upper thoracic vertebrae. The spines follow the occiput so the convexity of the lateral deviation (spinous processes) is to the side opposite that upon which the head rests. The lateral deviation is accompanied by some rotation of the bodies of the vertebrae these bodies moving in the direction of the face (compare with Fig 9 a to h).

In connection with the lateral rotation of the head there may be developed also a tendency toward lateral curvature of the cervical column. This is because of the fact that the final support of the head may pass to a higher or a lower level than its junction with the upper cervical pole which is thus called upon to ascend or descend while the lower cervical pole tends to be kept near its former level by its attachments to the shoulder girdle and the thorax (Fig 9 compare a to d with e to h). The transmitted stress increases with the extent of the rotation and as it is difficult for the cervical vertebrae to curve laterally the stress extends directly to all the tissues of the column of the neck. Attempts to relieve this stress by turning the rest of the body to follow the

head may increase the stress on the cervical column if the lower pole of this column is thus raised still higher above the supporting plane by the greater lateral extension of the shoulder to the outer side of the spine. This calls for a relatively greater descent of its upper pole to permit the side of the head to rest upon the same supporting plane. (It is important to note that the lateral position leads to a forward sliding of the whole shoulder girdle.)

A cephalocervical posterior concavity extending upward beyond the cervical region to the occipital protuberance is more or less evident (Fig 8 g Fig 9 a to h) according to the degree of backward extension of the occiput beyond the upper cervical pole and according to the amount of soft tissues present.

When the mandible the attached tissues in front of and to the side of the cervical spine and also the clavicle are removed and the head is then allowed to fall forward in spontaneous flexion the front of the cervical spine is seen lying in an anterior convex curve which is less marked than before dissection while the back of the cervical spine and the cephalocervical posterior concavity are both obscured by the soft tissues (similar to Fig 8 f compare with Fig 3 h). Then if the head is placed in midextension so that the face is in a plane parallel with the plane upon which the trunk rests the anterior convexity of the front of the cervical spine increases the back of the neck is raised from the table in a posterior concave curve which merges with the now visible cephalocervical posterior concavity both somewhat broken by the sagging of the soft tissues (Fig 8 g). As the soft tissues are gradually removed from the mandible and from the front and sides of the cervical vertebrae the tension and traction upon the clavicle and thorax progressively diminish these latter falling a little downward and backward (compare Fig 3 h with Fig 8 g).

Removing the soft tissues from also the back of the cervical spine and from the occiput below the protuberance but leaving the nuchal and other ligaments sufficiently intact to preserve the relations between the occiput and the cervical spine as well as between the individual cervical vertebrae and placing the head in forward flexion one notes the disappearance of all the cervical curves described. The cervical vertebrae with the exception of the atlas and perhaps a little of the axis lie in a straight line horizontally on the table the ring of the foramen magnum is carried forward and looks a little backward and downward and the atlas owing to its close connections follows the articular base of the occiput and with perhaps the aid of the axis forms the cephalic arm of a slight anterior cervical concavity. The cephalocervical posterior concavity almost disappears the head and neck lying on the table in almost a straight line from the lower part of the occipital protuberance downward (Fig 9 a b compare with Fig 8 e i j). In these illustrations the cervical anterior concave curve does not appear because in the dissected subject the apposition of the occiput and the atlas with the immediately succeeding cervical vertebrae is so close that the line of their separation is not shown. But as soon as the acuteness

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Development of the straight cervical spine with or without lateral deviation and with or without lateral curvature The foregoing experiments seem to demonstrate that extension of the head develops the cervical anterior convex curve while flexion of the head causes this curve to decrease or disappear and especially in the dissected specimen made by removal of all the soft tissues to be replaced by a more limited anterior convexity or even by a short high anterior cervical concavity the rest of the cervical vertebrae lying straight.

But further study of these experiments shows that the real factor in producing the above anterior cervical convexities is the anterior inclination of the cervical spine which is developed even when the head is in spontaneous flexion by arbitrarily displacing forward the articular base of the occiput and the closely connected more mobile upper cervical pole into a plane which is anterior to the plane in which the less mobile lower cervical pole is held by its continuation with the more stable thoracic vertebrae. And this forward displacement of the articular base of the skull which occurs in the supine position even when the head is in spontaneous flexion is increased with extension of the head because in the upward and backward rotation of the head upon a transverse axis which occurs when the head is extended the area of excursion of the back of the head is in this position limited by the resisting surface of the table upon which the head rests.

When this resisting surface is removed and the head left free to rotate the occiput takes its normal position posterior to the cervical vertebrae the articular base of the occiput is not displaced forward anterior inclination of the cervical spine does not occur and extension of the head to bring the face into the frontal plane does not produce a cervical anterior convex curve. The upper cervical pole (and its union with the articular base of the occiput) and the lower cervical pole then lie in the same plane and the cervical spine remains straight. Secondary modifying factors are the attachments of the segments of the cervical spine anteriorly to the cranium and to the front of the thorax including the thoracic portion of the shoulder girdle and posteriorly to the cranium and the back of the thorax including the back portion of the shoulder girdle (Compare Fig 9 a to h with Fig 10 a to h). A lateral deviation occurs also in the straight spine if the head is rotated to one or the other side. But the tendency toward the development of a lateral curvature as the result of the lateral stresses noted under the development of the cervical anterior convex curve does not exist in the same degree because in this position the straight cervical spine is supported by the horizontal plane upon which the trunk rests (Fig 10 c d g h).

In Fig 8 f d g t s n t d that the oc p t e t po the sam h rizo t l pla as th t upon wh h th tr kr t t with the h ad ext ded s to br th f n t the f t l p n pa llet th pl ne po h h th t u k r t Th t l ba of the occip t d pl d f r w a d c r y g w th t th p p r ce cal pol th d d l p an te t at on flex o f th c x l th c c p m d e r al or th c n t n c (Comp ew th f g 8 3 8)
 N w (f g h) f th d pl g ppo t em d f om th p t and th ce c l s p t ght ed th h d p r m tted to tate f ly p tran s e t l the f i the f n t l p l Th f r e or put s upp t d to ta th he d th pos t n t fou d th t the c r l s p ne em n t ght th tero cl ti no fl o s d v l p d r t o r p t r c pp d th c p t m es t t d read t the e l p d dorsad t th h tal pl pon wh h the tr k ts (c mpa ew th f g 8 e 4 5)

In f th ce p t e t up th m h rz tal plac as th t p wh ch th t u k t d w th th h d if d so th t th f l t a ngl f bo t 45 d g es t th pp t g pl Th t cu l b e f th ce p ut l k d w w d d back d (c ud d a d d r s d) c r y g w th t th t d p h p s m e les f th axi m kin a high cerv l anteri c ca ty gle

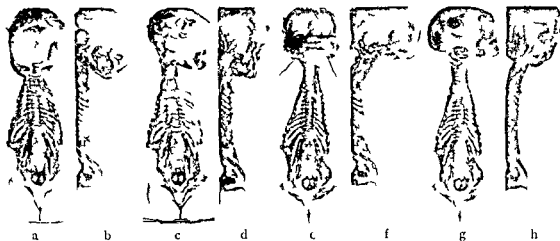


Fig. 12. Shows the cervical curves with the additional demonstration of the lumbosacral anterior convex curve a to h. The same subject and the same position a to c shown in Figure 9 except that the lower extremities have

been extended adducted and rotated inward thus adding in a forward and downward rotation of the pelvis and resulting in an extension of the lumbosacral anterior convex curve.

the rest of the cervical spine lying in a straight line (compare with Fig. 8 e, f).

If no change is made but to rotate the head so as to bring the face into the frontal plane (Fig. 11 d) a cervical or cervicothoracic anterior inclination or flexion and a cervical or cervicothoracic anterior convex curve are developed as in the preceding cases (compare with Fig. 8 e, 3, 8).

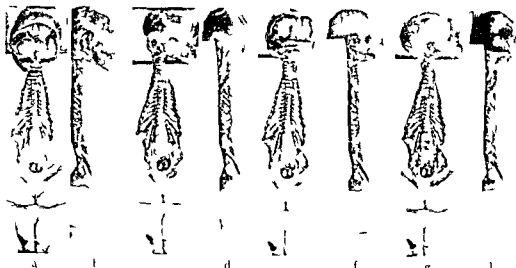
But if the cervical spine is straightened and the head allowed to rotate in the same way after all obstacles have been removed from the path of the occiput (Fig. 11 g) the cervical spine lies upon the horizontal plane while the occiput comes to rest dorsad to the line of the spine. And again there develops no anterior inclination or flexion nor curvature of the cervical or cervicothoracic spine this remains in a straight line (compare with Fig. 8 e, 4, 5).

In the casts in Figure 8 e, 4, 5 there is shown a high, light anterior concavity which may be due to the fact that the occiput was brought to rest at a slightly higher level than that which would bring its articular base into exact line with the cervical spine. If the support for the occiput be not adjusted exactly the atlas may rest on the edge of the horizontal plane supporting the cervical spine and the trunk. As a result the articular base of the occiput may sag, and this sag, transmitted to the anterior vertebral laminae may raise the cervical vertebrae in a slightly anterior convex curve from the second to the seventh with its maximum about the fourth. If on the other hand the articular base of the occiput rests on the edge of the horizontal supporting plane this causes it to move a trifle forward of the line of the cervical column perhaps carrying more or less with it the atlas and producing a slight anterior concavity similar to that seen in acute flexion of the head in Figure 8 e, 2, 6. When the occipital support is exactly adjusted the stress is divided equally between the anterior and posterior vertebral ligaments and no variation in the straight cervical column is observed.

In the supine position when the cervical spine is straight a slight anterior convexity is seen along the ventral surface of the lower cervical and upper thoracic vertebrae (Fig. 8 e, 1, 4, 5, 7 Fig. 11 a, d, g). This appears to be due to two causes: (1) the forward projection of the vertebral bodies due to the pres-

sure forward upon the spinous processes by the resistant supporting surface and (2) the increasing depth of the vertebral bodies and the increasing length of the spinous processes in this region. The spinous processes of the thoracic vertebrae continue to increase in length but they also become bent forward at an angle and become imbricated. As this change occurs the anterior convexity of the ventral surface decreases and the thoracic spine appears straight or by contrast with this temporary cervicothoracic anterior convexity and the definite lumbosacral anterior convexity the thoracic spine may appear to show a slight anterior concavity. As the cervical vertebrae are raised the pressure from beneath is lessened or removed the anterior convexity of the ventral surface disappears (Fig. 11 d Fig. 8 e, 3, 8) and the increasing depth of the bodies and backward projection of the spinous processes are clearly seen (Fig. 11 d).

Although the straight cervical spine is consistent with full extension of the head a cervical anterior convexity may be developed by continuing the rotation of the head into hyperextension this movement without forward inclination or flexion of the cervical column displacing backward the articular base of the occiput and the attached upper cervical pole (Fig. 7 compare e with d). Again with the head extended to practically a right angle with the uppermost cervical vertebra (the relation existing in the straight



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t n d sad t th t t e l p n lly m

t t t h t l pl h ch l (d d)
th th t p h h th t k t b t p ll t t
N t th b f th t l l t l h
th h l h b t t j t th th d l
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h t l d t t

cervical spine) the cervicothoracic spine may be inclined forward in a long, anteriorly convex curve. Without altering this long curve further extension of the head (hyperextension) would lead to the development of a cervical convex curve a just noted in the straight cervical spine (Fig. 11 c).

The cervical anterior convexity is not an organic curve at birth but is the result of postnatal factors. The final conclusion from this study is that no cervical curves are organic at birth all are postnatal and are developed as a result of the struggle between (1) the instinct to bring the face into the frontal plane and (2) an acquired forward inclination or flexion of the cervical or cervicothoracic spine. The former is antagonized and the latter is favored by the anterior connections of the head and of the neck and its viscera with the shoulder girdle and with the trunk and its viscera.

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The earliest postnatal factor moving toward the development of a cervical anterior convexity is interference with the backward projection of the occiput dorsad to the spine by the bringing of the occiput to rest upon the same plane as the more anteriorly attached spine as in the ordinary assumption of the supine position. This factor is present even when the head is flexed but its action increases as the head is extended. When the occiput is given free play to find its normal position dorsad to the cervical spine the cervical spine remains straight whether in flexion or extension.

The free movement of the cervical spine at term when the excursion of the head is not restrained allows the firmer fibrous tissues connected to the bone exercise a marked influence in the relation of the softer tissue related and more are removed while the

the bone exercise a variation in the relation of the vertebral and viscera) and the curve being these ti it seen ent ion

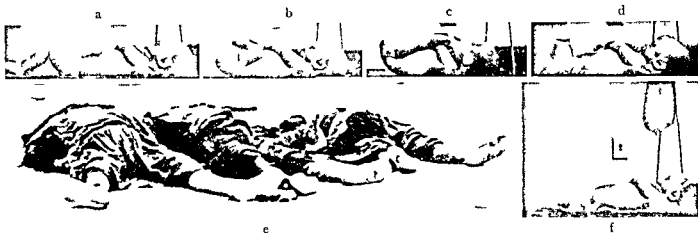


FIG. 14. Some intermediate stages occurring in the lower extremities as they pass from the prenatal position of flexion abduction and outward rotation to the advanced postnatal position of extension adduction and inward rotation so that the patella look forward. a Same subject as in Figure 13 but the head has been allowed to fall in spontaneous flexion with slight rotation to the right and with the lower extremities adducted and rotated forward in the plane of the spontaneous flexion of the thighs. Because of the firmness of the deep fibrous tissue contractions there is a slight return toward abduction and outward rotation of the legs and feet. b Same subject as in 14 a but approximate return to the intra uterine position of flexion of the lower extremities on the pelvis and of the pelvis on the spine. c Same subject and same position as

in b but with increased flexion of the pelvis and lumbar spine the knees are now extended and the thighs somewhat abducted to allow for the increased pressure of the abdominal contents from the increased flexion of the spine. d Same subject and same position as in 14 a but with the thighs adducted rotated inward and flexed at an angle of 90 degrees with the plane upon which the trunk rests and held in this position by being tied just above the knees to a vertical plank. On account of the firmness of the deep fibrous tissue contractions there is a slight return toward abduction and outward rotation of the legs and feet. e Newly dead adult men (Timothy, H. J. and H. J. Plato) showing spontaneous assumption of the at term position of abduction and outward rotation of the thighs but with the lower extremities extended at the hip and knee joints.

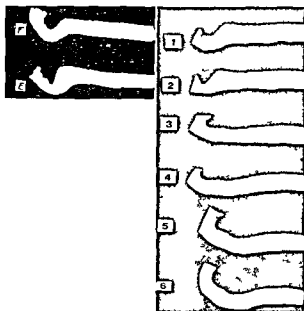
of the cervical or cervicothoracic spine is determined by the relative positions of the articular base of the occiput and the lower pole of this portion of the spine curved variations of the line of this anteriorly inclined spine depend upon variation in the balance of the muscles and viscera thereto attached the location of the angle of flexion depending on the location of the point or points upon which the force of the flexing factors converge. Hence the curve may develop more markedly from the upper pole or from the lower pole.

The ease with which at term the cervical spine can be straightened or overflexed or overextended suggests that in equilibrium has been evolved in the deep fibrous tissues as well as between the muscle flexors and extensors. But the cervical viscera remain to be considered and two facts regarding the cervical viscera attract attention in this direction: (1) these viscera are all located on the anterior or anterolateral portions of the cervical spine and (2) nearly all of these viscera have continuous relations with the flexor surface of the trunk spine and the trunk cavities and their contents.

THE LUMBOSACRAL ANTERIOR CONVEX ANGLE OR CURVE

It has already been shown that a lumbosacral anterior convexity (angle or curve) develops in prenatal life and is present at term even when the lower extremities fall into their spontaneous attitude of flexion abduction and outward rotation (Fig. 8 d 1). The lumbosacral anterior convexity differs from the cervical curves in that it is an organic curve being fixed in prenatal life by the connections of the involved bones although it is capable of functional modification. Its basis is a more or less pronounced hyperextension of the sacrum. But the study made in Figure 17 j k shows that antecedent to the hyperextension of the sacrum a lumbosacral rounded angle or an anterior convex lumbosacral curve is present in the straight spine this angle or curve being formed by the continuation of the lumbar vertebrae with the rapidly decreasing anteroposterior diameters of the sacral and coccygeal vertebrae.

This study has also shown how the lumbosacral curve is related to and modified by the position of the lower extremities (thighs)



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curve apparently develops as the anterior body concavity of the embryo straightens with extension of the spine and that it apparently become fixed as the pelvic bones become attached to the spine and to each other. Thus at term in attempting to restore the earlier anterior concave curve of the spine by flexing the pelvis upon the spine through the medium of the lower extremities and carrying the flexion progressively upward we can practically completely change the lumbosacral anterior convexity to an anterior concave curve only a slightly projecting ridge marking the location of the former lumbosacral angle. The organic nature of the curve is shown by the persistence of this ridge in spite of the flexion as a whole and by the compression which the act of flexion is seen to exert upon the intervertebral discs as high up as the eleventh or twelfth thoracic vertebra. By successive separations of the pelvic bone from each other and from the spine without other changes of position the lumbosacral anterior convexity can be gradually but entirely removed except for the line of demarcation at the upper end of the sacrococcygeal inclined plane (the lumbosacral angle) the inclination of this plane now appearing to be due to the decreasing anteroposterior diameters of these terminal vertebrae.

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forw d The th l m ba r t b r e a n t m d g g d
fo rd f th fifth th m m n t d c e g f m b
l w p w d a s th f r m of th t t chm t d c e
l f w th upp l m b t b r e e also d g g d
f wa d by th c t in pull of th f m act g th gh
the pso l c s Th lt the o rs f the l m

basal angle into an extended anteriorly convex lumbo sacral curve which may even extend upward so as to form a lumbosacrothoracic anteriorly convex curve (Fig 8 c d 2 Fig 12 a to h Fig 13 a to h)

Beginning with flexion of the lower extremities on the pelvis and of the pelvis on the spine as in the intra uterine position (Fig 14 b compare with Fig 1) and in increasing the flexion as in Figure 14 c but to a still greater degree the lower extremities become more and more abducted we find that the lumbosacral curve and angle disappear except for a slight reminiscent ridge at the site of the former angle. The lumbar spine and the sacrum now form a continuing line very slightly curved with the concavity anterior for this curved line caudad to the line of the thoracic spine being in slight hyperextension. Several slight subsidiary ridges above and below the lumbosacral ridge show the amount of pressure and tension under one by the intervertebral discs. The tip of the sacrum and the coccyx continue the floor of the pelvis in a curve the concavity of which looks cephalad. Hyperextension of the spine which formerly began with the sacrum is now seen beginning faintly in the upper lumbar vertebrae (Fig 15 3 4). In 3 the thighs are more abducted so that the knees rest on the buttocks just outside of the ribs.)

If the flexion is still more increased the lumbosacral concave curve deepens yielding being least in the lower lumbar and upper sacral regions. More of the sacrum enters into the pelvic floor which deepens and grows broader from behind forward. Hyperextension of the lumbar spine is now definitely indicated being more marked above, less marked below as it curves forward to join the sacrum (Fig 15 5).

Finally increasing the flexion to about the lumbosacral junction we find that the crests of the ilia point practically downward and the anus points upward and a little backward. The lumbosacral concavity deepens the higher lumbar and the lower sacral vertebrae entering into it more definitely the lower lumbar and the upper sacral regions still yield least. The floor of the pelvis broadens still more from behind forward as more of the lower sacrum tends to enter into it. Hyperextension of lumbar spine is more pronounced above and less marked below (Fig 15 6).

When the lumbosacral anterior convex curve is developed to a maximum by extending adducting and rotating inward the lower extremities so that the patella look forward and then an incision is made through the symphysis pubis the lumbosacral anterior concavity shows a definite relaxation and flattening of the curve (Fig 17 a b). If additional incisions are made through both sacroiliac articulations the lumbosacral anterior concavity shows a much more marked relaxation and flattening of the curve (Fig 17 c d). The extension of the sacroiliac incision on the right side upward through all the soft tissues to the fifth rib causes further marked relaxation and almost complete disappearance of the curve with sagging of the left pelvis and loin rotation of the pelvis and lumbar vertebrae to the left and development of a long, left lumbosacral concave curve which can be traced as high as the second thoracic vertebra. On the left side the tense psoasiliacus is seen holding up the left pelvis (Fig 17 e f).

Connect the right lateral incision with that through the symphysis and continue it up and along the right side of the whole spine. We note that the lumbosacral posterior concavity has disappeared but light may still be seen in a small arc and tension on the left psoasiliacus is well shown. Remains of the long left concavity can be traced especially in the midthoracic vertebrae but the lower thoracic and especially the upper lumbar vertebrae are drawn to the left by the psoasiliacus and quadratus

lumborum the sacrum and coccyx swinging to the right because of the separation of the sacroiliac articulation (Fig 17 g h).

After the removal of all tissues on the left of the spine as previously done on the right the spine lies straight and flat the only trace of curvature being the postural anterior concavity at the cervicothoracic junction already noted (the anteroposterior diameters of all the vertebrae increasing with the sum of the diameters of the bodies and the backward projection of the laminae and spinous processes as the spine rests on a non yielding surface) and the anterior convex curve of the anterior surface of the junction of the fifth lumbar vertebra with the sacrococcygeal inclined plane or anterior concave curve no posterior spinal concavity existing when the head is allowed to extend without obstruction to the occiput (Fig 17 i j k).

SACROCOCYGEAL ANTERIOR CONCAVE CURVE

The sacrococcygeal anterior concave curve is an organic curve developed in prenatal life and present at term.

Beginning with the attempt to restore the embryonic anterior concavity of the spine from the lower thoracic region to the coccyx (Fig 15 6 compare with Fig 16 17 15 16 and with Fig 14 c) and reversing the steps of this experiment one sees that progressively as the flexion of the lumbar spine and pelvis decreases and moves into extension the lumbar spine decreases in hyperextension and falls into line with the thoracic spine the latter losing the slight concavo convex line developed by the stress from below and becoming straight (or with a very slight anterior concave curve) (Fig 15 5 4 3 F compare with Fig 16 15 16 13 14 11 12 1 2 and with Fig 14 c b d Fig 2 a). At the same time the sacrum first follows the lumbar spine in becoming straight (Fig 15 4 3 and then moves into hyperextension (forming the lumbosacral angle whose apex is directed anteriorly) being now directed obliquely downward and backward with a tendency to become slightly concave anteriorly particularly in its lower portion (Fig 15 F compare with Fig 16 1 2 and with Fig 2 a). The coccyx follows the sacrum but does not so entirely lose its forward direction thus giving with the lower part of the sacrum a definite suggestion of anterior concavity to the posterior wall of the pelvis (Fig 15 F, Fig 8 c 1 to 8 compare with Fig 16 1 2).

However other processes than extension and hyperextension of the spine are involved in the production of the sacrococcygeal anterior concavity. Figure 17 i j k show the



marked change which have taken place in the vertebrae as compared with those more cephalad especially in the direction of diminution of their ventrodorsal diameter the factor tending to produce an anterior oblique or concave line when seen in profile even though no posterior convexity appear.

MODELING OF THE PELVIS

Modeling of the pelvis (the abdominal floor) by the lower extremities and the lower spine. This study has previously shown that flexion and extension of the lower extremities (thighs) produce respectively backward and forward rotation upon a transverse axis of the pelvis as a whole and the preceding study of the

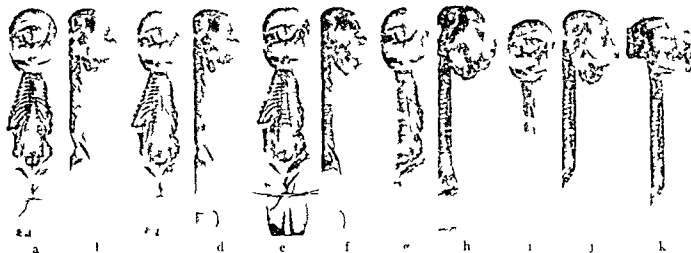


Fig. 13. Experimental study of a second path of development of the lumbosacral anterior convex curve developed retrogradely by successive sections of the attachment of the pelvic bones to each other to the spine and to the thorax. Consequent reduction of the spine to its earlier condition of absence of all organic curvature except the lumbosacral angle which latter now appears to be due merely to constant anteroposterior deficiency in the sacrococcygeal vertebrae. a, b. Same subject as in Figure 13 (Fig. 13). The lumbosacral anterior convex curve is developed to its maximum by extending adducting and rotating inward the lower extremities. Then section through the symphysis pubis results in a definite relaxation and flattening of the curve. c, d. Added incisions through both sacroiliac articulations result in a marked increase in the relaxation and flattening of the curve. e, f. I extend the right sacroiliac incision upward through all the soft tissues to the twelfth rib causes further marked relaxation and almost complete disappearance of the curve with a gain of the left pelvis and loin rotation of the pelvis and lumbal vertebrae to the left and development of a long left lumbosacral anterior convex curve which can be traced as high as the second thoracic vertebra. The left psoas iliacus been holding up the left pelvis. g, h. Connecting

the right lateral incision with that through the symphysis and continuing it upward along the right side of the whole spine the lumbosacral posterior or concavity disappears from view though it may still be seen through a small arc and tension on the left psoas iliacus is well shown. Remains of the long left concavity may be traced especially in the midthoracic vertebrae but the lower thoracic and especially the upper lumbar vertebrae are drawn to the left by the psoas iliacus and the quadratus lumborum the sacrum and coccyx swing round to the right owing to the separation of the sacroiliac articulation. i, j. After removal of all tissues on left of spine already done on the right and flexion of the head we find that the whole spine lies straight and flat the only trace of curvature being the slight anterior concavity at the upper cervical pole the slight anterior convexity at the cervicothoracic junction (both of the curves having been already noted as being functional and been so demonstrated) and the anterior convex curve or angle formed by the junction of the fifth lumbar vertebra with the sacrococcygeal inclined plane or anterior concave curve no posterior spinal concavity appears. k. When the head is extended and the excursion of the occiput downward to the spine is unrestrained the anterior concavity of the upper cervical pole disappears

position of the lower extremities in extension adduction and inward rotation

a. The spontaneous position of flexion abduct on and outward rotation of the lower extremities (thighs) is accompanied by a practically straight lumbosacral spine and by an obtuse lumbosacral angle (apex ventrad) rather than by a very definite lumbar anterior convex curve. From this angle the sacrum is directed obliquely dorso-caudad to the horizontal then slightly curving caudo-ventrad it forms a short curve whose concavity looks ventrad. The pelvic cavity is rounded resembling the end of an elongated melon. The pelvic floor looks rather directly caudad it is almost vertical (dorsoventrad) but forming a slight curve whose concavity looks cephalad (Fig. 1, F compare with Fig. 16, I and with Fig. 2).

b. Then the adduction and the rotating inward of the thighs so that the knees approach each other (without mechanically altering the angle of flexion) cause a definite convex curve to appear in the lower lumbar vertebrae the upper lumbar and lower thoracic vertebrae sagging a little into the slight anterior concavity before the former straight line of the thoracic spine is gained. The stress upon the spine is shown by the projection of the intervertebral discs

from the fifth lumbar to the eleventh thoracic. The sacrum passes obliquely dorso-caudad as in Fig. 1 but apparently to a lesser extent passes into the sacrococcygeal concavity which looks ventrad. This concavity is lengthened and it is more flattened approach more the horizontal. And while the dorsoventral depth appears shallower it is really the same in its more cephalad portion and increased in its more caudal portion. The pelvic cavity has no v become bowl-shaped its cephalocaudal diameter is lengthened it is narrowed laterally and its depth is increased to and the pelvic floor. The pelvic floor is directed a little more obliquely ventro-caudad (Fig. 15, I compare with Fig. 16, 3-6 and with Fig. 1, 14 a).

c. Then if a tension of the thighs and knees is added the lumbar anterior convex curve becomes more pronounced and extends further cephalad involving more levels of the thoracic spine. The lumbar sacral angle approaches a well rounded right angle all the lumbar and some of the lower thoracic vertebrae project ventrad in a marked anterior convex curve decreasing cephalad and sagging into a slight anterior or concave curve just before the straight line of the thoracic spine is regained. The sacrum passes dorsad almost at a right angle and almost in a straight line which includes the upper part of the coccyx. The rest

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THE THORACIC SPINE

The straight thoracic spine the anteriorly convex thoracic spine In the supine position when the adjacent cervical and lumbar spine are straight the thoracic spine is straight when the adjacent cervical and lumbar spines are curved in anterior concavity this latter curve may extend into the thoracic region (Fig 11 c Fig 13)

When the forward pressure of the resting surface of the table upon the increasingly backward projecting spinous processes produces an anterior convexity at the cervicothoracic junction a slight relative concavity of the

adjacent thoracic spine is produced (Fig 8 c 1 2 4 5 7 Fig 11 a g compare with d compare with Fig 17 j k)

In proportion as cervical and lumbar anterior convex curves extend into or involve the adjacent thoracic vertebrae a more or less marked relative anterior concavity of the adjacent thoracic spine is developed (Fig 8 d e 3 8 Fig 9 compare with Fig 10 Fig 1 compare with Fig 13) Hence an anterior concavity of the thoracic spine is a functional and not an organic curve and it is related to both the cervical and the lumbar spine

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ROTATION OF THE THORACIC CAGE

The thoracic cage has already been noted as rotating upward and forward upon a transverse axis when the lumbar anterior convex curve developed by extension adduction and inward rotation of the lower extremities extend cephalad so as to involve the lower thoracic vertebrae. It has also been noted that this action is accompanied by increased stress upon the abdomen and its contents with forward projection of its anterior wall and by downward and forward rotation of the pelvis upon a transverse axis with descent of the symphysis (compare Fig 14 f with Fig 2 a Fig 8 c with 8 a Fig 6 e f h h with Fig 3 i f g h)

A similar upward and forward rotation of the thoracic cage occurs when the upper extremities are raised either in front or at the side so that the humerus approaches the side of the head (ear) (Fig 8 h compare with 8 a) the raising of the upper extremity meeting with greater resistance in proportion to the elbow is extended. If this resistance be disregarded and the elbow extended the upward and forward rotation of the thoracic cage is increased (Fig 8 i) A the thoracic cage is thus pulled upward and forward it tends to

drag the lower thoracic or thoracolumbar vertebrae forward into anterior convexity and to cause changes in abdominal stress and projection of the anterior walls similar to those just described. This rotation of the thoracic cage with its accompanying abdominal changes tends to be increased when the head is extended (Fig 8 j) and also when the lower extremities (thighs) are extended adducted and rotated inward so that the patella look forward (Fig 8 c) the rotation and its connected changes reaching their maximum when all three factors are combined (Fig 8 k).

Rotation of the thoracic cage by the upper extremities is due to contractions (relative shortness) of the deep fibrous tissues connecting these extremities with the trunk and the forearm with the arm. These fibrous tissue contractions have a biological origin similar to those connecting the lower extremities with the trunk and the leg with the thigh but they are much less extensive than these latter. In the most advanced postnatal development of the human type the humerus can be raised to the side of the head (ear) without acting upon the thoracic cage spine or abdomen.

A third form of upward and forward rotation of the thoracic cage with similar abdominal involvement is observed in connection with some activities of the diaphragm. This form will be studied in the next chapter on *The experimental development of the splanchnoptoses and their relation to the body form*.

SUMMARY

1 The evolution of the human type is not completed at birth. The position of flexion, abduction and outward rotation which the lower extremities (thighs) spontaneously assume at term marks a stage in their evolution from an earlier biological position towards the advanced postnatal human position of extension, adduction and inward rotation so that the patellae look forward.

2 Similarly the upward and forward rotation upon a transverse axis of the thoracic cage observed at term when the upper extremities are raised either in front or at the side so that the humerus approaches the side of the head (ear) marks a stage in the evolu-

tion of these extremities from an earlier biological position toward the advanced postnatal position in which the humerus can be raised to side of head (ear) without acting upon the thoracic cage spine or abdomen.

3 The human prenatal and at term positions of both the upper and the lower extremities have demonstrable functional advantages in sub human types of animal life but persistence of these positions in the human being indicates retarded incomplete or reverse evolution of the individual in these directions. Tendencies toward this persistence are always present until the advanced evolution of the body form is attained. Even when attained this body form tends to be more or less unstable according as one or the other of two instincts is the more dominant. The instinct toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera) the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera) which are relatively short along lines made strong by older biological paths. Whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly movement then being in the direction of reversion toward earlier (prenatal) forms.

4 The at term position of the lower extremities is due to firm contractions (relative shortness) of certain of their deep fibrous tissues and the connections of these fibrous tissues with those of the pelvis and lower spine and through these latter with the more cephalad parts of the body.

5 Changes in the developing positions of the lower extremities and their connections are intimately related to modifications of the body form particularly with reference to all abdominal walls (anterior posterior lateral superior and inferior) as well as to modifications of the positions of the contained viscera in the direction of splanchnoptoses.

6 The abdominal walls are thus so intimately co-ordinated with the spine the pelvis the thorax the upper and the lower extremities and even the head that some

study of all the latter is necessary to an understanding of the former

7 As the advanced postnatal position of the lower extremities (thigh) in the direction of extension adduction and inward rotation so that the patella look forward is experimentally developed at term in the supine position the following changes in the body form occur synchronously: the trunk thigh lateral angle disappears and the whole trunk appears to narrow and elongate; the pelvis rotates downward and forward on a transverse axis and the symphysis pubis descends; the lumbosacral region arches forward in marked anterior convexity; this anterior arching may involve the lower thoracic spine and then upward and forward rotation of the thoracic cage upon a transverse axis is added; the abdominal cavity is contracted from behind forward by the throwing forward of the lumbosacrothoracic and the iliac region; and it appears narrowed from side to side especially in the region of the loins; the viscera are thrown forward and downward causing increased stress upon the anterior and anterolateral walls which are lengthened by the descent of the symphysis (and perhaps also by the ascent of the thoracic cage) while the back appears shortened by the increased lumbosacrothoracic posterior concavity. The relations of the femur are changed so that it is now convex forward instead of forward and outward; the outer surface of the great trochanter looking backward and outward instead of backward; modeling of the trunk pelvis thighs legs and feet develops. The legs describe a slight curve with the concavity medially instead of forward and inward and the feet continue the curve of the tibia causing supination of the feet with a tendency of the forward part of the feet to overlap.

8 At term the supine position reveals four anteroposterior spinal curves: two organic (the lumbosacral and the sacrococcygeal) and two functional (the cervical and the thoracic).

9 The cervical anterior convex curve is developed as a result of the struggle between (a) the instinct to bring the face into the frontal plane and (b) an acquired forward inclination or flexion of the cervical or cervicothoracic spine. The earliest postnatal factor

moving toward the development of a cervical anterior convexity is interference with the backward projection of the occiput dorsad to the spine by bringing the occiput to rest upon the same plane as the trunk or upon a more anterior plane as in the ordinary assumption of the supine position thus producing a forward inclination or flexion of the more anteriorly attached cervical or cervicothoracic spine. This factor is present even when the head is flexed but its action increases as the head is extended. When the occiput is given free play to find its normal position dorsad to the spine the cervical spine remains straight whether in flexion or extension. The straight and the curved cervical spine assist respectively in the elevation or depression of the thoracic cage.

10 The experimental evolution of the lumbosacral anterior convex curve may at term be developed retrogressively along two paths and it seems to show that the curve apparently develops as the anterior body cavity of the embryo straightens with extension of the spine and that it apparently becomes fixed as the pelvic bones become attached to the spine and to each other.

11 Progression toward the development of the advanced postnatal position of the lower extremities assists in modeling the pelvic cavity and the lower spine the modeling being similar in the two sexes. The pelvis is constantly in a condition of unstable equilibrium so its angle of inclination its axis the contents of its cavity and its relations as the floor of the abdominal cavity are continually shifting more or less.

12 The upper extremities and the head modify the body form largely through the spine and through their action upon the tendency of the thoracic cage toward rotation upon a transverse axis.

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PERIOSTEAL TRANSPLANTS IN THE REPAIR OF DELAYED UNION,
UNUNITED FRACTURES, AND LOSS OF BONE SUBSTANCE¹By HARRY I. MOCK, M.D., F.A.C.S., Chicago
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A YEAR ago I presented a paper before this society on the value of periosteal grafts in the repair of delayed union, ununited fractures and loss of bone substance. The practical application of the method as shown by some 10 clinical cases presented was lost sight of in the prolonged discussion relative to "How Does Bone Grow?"—a controversy almost two centuries old in the age of modern surgery and undoubtedly a favorite bone of contention among the ancients.

In SURGERY, GYNECOLOGY AND OBSTETRICS the official organ of the College of Surgeons one finds so many articles on the experimental studies of bone regeneration that the student is soon lost in the maze of conflicting statements. Reviewing this journal from its last issue back to January, 1921, one finds at least a half dozen articles dealing with this controversial subject. Other journals, especially the German and French, are replete with similar articles.

S. F. Haas (4) quoting Keith gives an excellent review of the theories and beliefs held by many investigators down to the present time. As a result of his own experiments Haas ascribes the greatest osteogenesis to the periosteum, a certain amount of osteogenesis to the endosteum—an ability to form new bone cells but lacking the power to cement together the fractured fragments—and very little if any osteogenesis to the cortex when stripped completely of its periosteum and endosteum.

Since Haas' publication Carl Rohde (7) of Freiburg, Germany, has published an exhaustive experimental study of "How Does Bone Form?" He found three sources of osteogenesis, namely the chief source from the cambium or inner layer of the periosteum, the next source from the endosteum, and a certain amount of regeneration from indifferent mesenchyme cells lying near or in the connective tissue surrounding bones. (He

describes bone formation in remote tissues of the body, as in the abdomen, in scars, in the heart muscle, etc., as due to these indifferent mesenchyme cells lying in adjacent connective tissue which through trauma, infection, toxic stimuli, or metabolic disturbances abandon their indifferent stage and begin to build bone.) He feels that he has proved the ability of connective tissue cells to undergo a metaplasia. He gives as a law the following:

Fundamental prerequisites for bone formation are living osteoblasts or unused remaining mesenchyme cells which can develop into osteoblasts. These bone building cells, living osteoblasts, take from the living organism the organic and inorganic substances needed for bone building.

Rene Leriche and Albert Policard (5) of Strasbourg and Lyons, France, have published an exhaustive study entitled "The Problems of the Normal Physiology and Pathology of Bones" (Paris: Masson et Cie, 1926). In a short article (6) in September, 1926, they reviewed their conclusions and here we have a new element injected into this very old controversy. They state emphatically: "The periosteum has no true osteogenic action. It checks osseous infiltration which spreads widely. (The old 'limiting membrane' theory for periosteum.) They continue:

"The periosteum does not cover an osteogenic layer with numerous osteoblasts. This conception is purely a theoretical one. It becomes necessary only if an indispensable and fundamental part is given to the osteoblasts. But when the periosteum is modified by a change of circulation or by oedema it becomes then a ground for ossification. It is passively ossified—it does not make bone in an active manner."

The formation of bone is a result of the metaplastic change in the connective fundamental substance. This metaplasia takes place in three ways: (1) transformation of the connective tissue by an oedematous infiltration with a multiplication of connective fibrils, (2) infiltration by a special substance chemically defined—the pre-osseous substance

(3) deposits in that substance of a calcareous mixture of calcium phosphates and calcium carbonates. Ossous metaplasia can occur in all types of connective tissue embryonal type fibrous type etc

They further describe the characteristic changes in bone in the neighborhood of fractures which we have heretofore ascribed to atrophy from disuse and state

It seems that as a result of rarefaction of bone there is produced a localized oversupply of calcium which provokes an ossous metaplasia in the surrounding connective tissue

Contrary to this last statement we have the conclusions of Allison and Brooks (1) in an article on Bone Atrophy to the effect that non use of an extremity resulting in bone atrophy has no effect upon the regeneration of bone at the site of bone defect. They showed that bone atrophy caused no increase in the amount of organic or inorganic salts and concluded. The process of bone atrophy is not a change in the characteristics of bone as a substance. It is a change only in the amount of bone present. The chemical composition remains unchanged.

Thus the problem of how bone regenerates following a fracture or loss of continuity is still a muted one. In reviewing the literature and in following his own experimental work, one is impressed with the similarity of all animal experimentation on the subject and the efforts of most investigators to prove or disprove the limiting membrane theory of periosteum, the presence and location of a cambium layer and the presence of or lack of osteogenesis in one or all of the three bony layers.

The recent work of Leriche and Policard is a notable exception to past investigation. While their conclusions may not be accepted yet they should serve to stimulate others to attack this problem from the functional physiological and chemical standpoints.

As a result of all the years of experimentation by many investigators and the practical application of certain methods by various surgeons, the autogenous bone graft has become a fixture in bone surgery. At first only the cortex was transplanted and we can readily understand the contentions of Murphy and other that this graft served

only as a bridge the graft itself dying and being replaced by new bone growing out across this bridge from the end of the fragments. Cortex alone has very little osteogenesis.

Later Albee, Lewis, Phemister, Cotton and a host of other surgeons advocated the use of all three layers in the bone transplant periosteum, cortex and endosteum. Reports of their results combined with animal experiments seemed to prove conclusively that such a graft lived. We know from experience that it repaired the defect in a bone caused by ununited fracture, the removal of a tumor or other cause.

However, without exact knowledge as to how the bone regeneration occurred or which layer of the graft was responsible for its viability and osteogenesis, the practical result of reconstruction of the bony defect in the skeleton was cured. Those of us who have used this graft know its value.

Delagiere (2) opened a new chapter in bone surgery with his report of results in the use of the osteal periosteal transplant. He describes his technique for an implant to promote regeneration of bone. It is not a graft but merely supplies the elements indispensable for formation of bone. He declares that contrary to what Albee says it is possible to reconstruct any part of the skeleton and cure any pseudoarthrosis and obtain the desired results in a simple, effectual and more certain manner than with Albee grafts. He obtained excellent and complete results in 244 of his 273 cases. The graft should consist of the periosteum lined throughout with a thin layer of bone. The bone strengthens the transplant, holds the periosteum stretched and keeps it in good shape to facilitate the reconstruction of the bone. A tibia can furnish about 22 centimeters of such transplants. His illustrations show how he rolls up a rectangular graft on the periosteum side to insure a proper curve to fit in its new bed. The bone periosteum strips are implanted side by side, end to end and overlapping the bone side toward the bone bed. The edges are slipped under the periosteum all around. When an angular space is to be filled in, he ties two sheets together at an angle, the

flaps are kept in place by suturing the soft parts

Goodwin in 1800 first ascribed osteogenesis to periosteum. Ollier in 1857 described the subperiosteal resection of diseased bone showing that the repair of the defect occurred from the retained periosteum. Albee was one of the first to insist that periosteum must be included in the bone graft. Harris and later Rohde in their experiments attributed the chief osteogenic ability to periosteum. Delageniere emphatically claims that his osteal periosteal transplant is superior to the bone graft because it contains more of the periosteum, the element indispensable for bone formation.

Leriche and Policard refute this claim of active osteogenesis in the periosteum but state that the periosteum is modified by change of circulation or oedema and thereby becomes the ground for ossification—it is passively ossified.

The outstanding fact in this resume is that *to periosteum alone of all the bone layers is ascribed a definite role in bone regeneration.*

In addition to this uniformity of opinion concerning some power in the periosteum for bone regeneration I have repeatedly observed the following facts which give additional weight to the argument in favor of periosteal osteogenesis:

1 When the bone is exposed at operation for old ununited fractures the cortex is roughened and completely denuded of periosteum for a distance on either side of the site of fracture. The ends of the fragments may be osteoporotic or osteosclerotic but in either event periosteum is absent for a variable distance from the ends of the fragments.

2 In cases of delayed union of fractures following severe trauma or trauma from repeated efforts at reduction which are finally operated, the periosteum is very thin, almost impossible to raise without tearing and shredding and oftentimes has completely disappeared from the ends of the fragments.

3 In the application of a Lane plate in a recent fracture say within the first 2 weeks the results are far better than when a Lane plate is used in a case of delayed union or an

ununited fracture. In the latter case the plate is usually applied to a bone with very poor periosteum or one completely denuded of it.

4 Subperiosteal resection of ribs phalanges metacarpal and metatarsal bones for osteomyelitis other than tuberculous almost uniformly results in regeneration of the bone evidently from the retained periosteum. When the periosteum is completely removed with the bone proper this regeneration does not occur or is greatly delayed.

5 We have sacrificed 8 dogs in the last year in an endeavor to secure regeneration of bone across gaps of varying lengths by means of a pure periosteal graft. In dogs the periosteum is so thin that it is almost impossible to raise it without shredding providing no cortex is left adherent to it. Thus far we have not succeeded in closing in this bony defect with a periosteal transplant in a single instance. We have found however that when we completely denude the bone of periosteum for a distance of 3 to 4 centimeters on either side of a transverse fracture or from the ends of the fragments in the case of the removal of a small section of the entire bone non union results. The absence of periosteum at the site of and adjacent to the fracture resulted in non union in 6 cases examined from 3 to 6 months after this operation. In 3 of these cases bone regeneration had commenced but in each instance it was at the margin of the periosteum and not at the ends of the fragments (Fig. 1).

From these observations and from the clinical cases about to be reported the following conclusion is justified: *Periosteum is necessary for the regeneration of bone and therefore in cases of delayed union ununited fractures and loss of bone substance periosteal transplants when properly fitted about the site of the damaged bone will result in healing and reconstruction of the defect.*

In making this statement I do not claim that periosteal transplants are superior to the osteal periosteal transplants in all cases nor to the generally recognized autogenous bone graft in certain cases. I believe in many instances a certain amount of cortex removed with the periosteum is advantageous chiefly

because it gives strength shape and foundation to the transplant. I believe further that in the larger bones where there is a considerable loss of continuity the osteal periosteal transplant or the autogenous graft is superior to a pure periosteal transplant. But in these cases I will in the future remove as large an amount of periosteum as possible with the bone graft.

Periosteum alone of all the three layers of bone has received the majority of votes of all investigators as being the one layer most indispensable in osteogenesis. Bearing this in mind let us evaluate the various kinds of transplants and grafts.

A Cortical graft

1 Of the least value because it contains no periosteum.

2 It serves chiefly as a means of internal splinting but as such is superior to any inorganic or heterogeneous internal splint.

B Autogenous bone graft

1 Of more value because it contains some periosteum.

Because of the narrow strip of periosteum which this graft usually contains it is of less value than those methods which transplant larger amounts of periosteum.

3 The cutting and transplanting of this graft require more time a much more cumbersome technique and considerably more trauma than either the osteal periosteal or periosteal transplant.

4 Its one advantage over the latter two transplants is that the solid cortex contained in this graft furnishes an excellent means of internal splinting or fixation of the fragments a point of special value where there is a wide loss of continuity.

C Osteal periosteal transplants

1 Of great value because wide strips of periosteum can be removed with a thin layer of cortex.

2 Such a transplant can be removed more quickly and planted in the bony defect with far less technical difficulty than either the cortical or full bone graft.

It is superior to a pure periosteal graft only in those cases in which a loss of bone substance makes it necessary to hold the periosteum more firmly and in a given shape

for example in the form of a cone or a wide plate.

4 It reconstructs the defect in the bone more rapidly than is the case with the usual bone graft—because of the presence of a greater amount of periosteum.

D Periosteal transplant

1 Of great value because of the large size of the transplant which can be removed a much larger piece of periosteum than the narrow strip usually adherent to the autogenous graft.

2 It can be removed with a blunt instrument stripped off readily and more quickly than either the osteal periosteal or full bone graft.

Because of its thinness it can be wrapped about tucked in and brought into the closest apposition with the bone fragments to be repaired.

4 It can overlap the ends of the fragments and be sutured to the edges of the periosteum remaining on the bone often at a considerable distance above and below the site of bone defect.

5 There is far less trauma to the bone from which a periosteal graft is obtained than when a complete bone graft is made. The healing of this additional wound is quicker and less painful.

6 The technique of a periosteal transplant is much simpler can be performed far more rapidly and there is less operative trauma to the already damaged bone especially to its adjacent periosteum which is frequently peeled off and markedly destroyed because a greater amount of the shaft must be exposed in doing a complete bone graft especially a sliding graft.

7 In my hands it has given quicker reconstructive results than have my cases of autogenous bone graft. I cannot thus far see any material difference between it and osteal periosteal transplants as to rapidity of repair. I begin to believe that the latter has the advantage when there is a loss of bone substance.

We know autogenous bone grafts are a success. We know that osteal periosteal transplants are a success and are receiving more and more favor as a simpler procedure.

The chief reason for continuing the use of pure periosteal grafts is to prove or disprove their value and if they continue to prove successful then they surely form the simplest method yet devised for the repair of delayed union and of ununited fractures except perhaps those with marked loss of bone continuity.

CLINICAL OBSERVATIONS OF PERIOSTEAL OSTEOGENESIS

Animal experiments often fail to give the true counterpart of similar conditions in the human body. It would seem therefore that for practical surgical purposes carefully recorded observations of our experiences with bone work in the human should receive the greater consideration in arriving at our conclusions. With this in mind I wish to report my clinical experiences during the last 4 years with periosteal grafts leaving certain experimental problems which have grown out of the work to be reported at a later date.

In 1912 I operated on a young lady for a bone cyst of the proximal phalanx of the fifth finger. In the freeing of the soft tissues from this bone shreds of the periosteum were peeled off also. The entire diaphysis of the phalanx was then removed and the defect was filled in with a cortical bone graft taken from the tibia. The transplant was composed only of cortex. Subsequent X-ray examinations made at intervals of 2 to 3 weeks showed bony regeneration occurring first along the inner margin of the transplant *but separated from it*. There was no question but what the new bone was growing from remnants of the periosteum and not from the cortical bone transplant. The latter showed no evidence of bone regeneration but finally became fused with the new bone growing inward from the periosteum.

This same year I resected the upper end of the humerus for bone cyst with pathological fracture in a boy of 17 years. The defect was bridged with a 6 inch bone graft from the tibia. This time I carefully included periosteum cortex and endosteum in the graft. Frequent X-ray observations showed bone regeneration but most marked and first noted along the periosteal side of the graft and espe-

cially between the periosteum of the host and periosteum of the graft.

During the next few years I had several cases of autogenous bone grafts in ununited fractures after removal of bone tumors in repair of skull defects and in certain plastic operations on the nose. In spite of infections fracture of the grafts and the usual complications the average surgeon in bone work meets union in all cases was obtained but often months and in one case 2 years elapsed before the desired end was gained. Observation and experience taught 3 things: first quicker results were obtained when periosteum was included in the graft; second the larger the amount of periosteum transplanted the earlier did a large amount of callus form; and third in many cases of old ununited fractures the bone fragments were sclerosed and completely denuded of periosteum and in these periosteum as a part of the transplant was absolutely necessary.

Subperiosteal resection of a portion or of the entire shaft of a bone the seat of osteomyelitis has been advocated by a few authors since Ollier first described this procedure in 1857. Bruman and Campbell (2) give an excellent report of this procedure in a number of cases and conclude that regeneration of the shaft takes place from the retained periosteum; that the role of the endosteum in the regeneration is slight and that success can be obtained in all but about 10 per cent of cases other than tuberculosis. I have performed subperiosteal resections for pyogenic osteomyelitis of the phalanges metacarpals and metatarsals in over 50 cases also in several cases of the larger bones. The periosteum often in shreds is carefully peeled away from the diseased bone with the surrounding soft tissues. The length of the member is maintained by traction. Following this procedure the regeneration of the diaphysis of the bone can be observed by repeated subsequent roentgenograms. The first picture will show a complete absence of bone while the subsequent films show the gradually increasing shadow of bone growing in from the retained periosteum. This periosteal regeneration of bone stimulated undoubtedly by the infection and over rich in osteoblasts because of

the early stages in involucrum formation nevertheless demonstrates for practical purposes the great osteogenic properties of perio teum

My experience with operating upon recent fractures is limited and is becoming less extensive each succeeding year of practice. A review of the records of the last 500 cases of recent fractures admitted to my service at St. Luke Hospital shows that in only 31 cases have open operations been performed. Experience teaches one to be content with a fair anatomical result rather than to seek for a perfect alignment of the fractured fragments as shown by the X-ray picture. The latter desire necessitates more frequent operations the former eliminate open reductions and in the end gives quicker and more uniform good result.

When a recent fracture is operated upon there is added to the original trauma the operative trauma. The original trauma has already done considerable damage to the periosteum as is shown by the edema, hemorrhage and shredding of the periosteum. The operative trauma can add markedly to this damage. Frequently we see the bone completely denuded of periosteum during the act of exploring the site of fracture and after reduction and some means of fixation has been applied the wound is closed with the site of fracture still denuded of periosteum. This to my mind is the chief reason for the longer delay in securing union in open reduction of fractures and accounts for the greater number of non union cases following operation as compared with closed reduction. Repeated efforts at closed reductions in the same case will likewise frequently result in non union. Here again the additional trauma is responsible. Just as we have been so thoroughly drilled in the importance of closing the peritoneum before closing the other layers of the abdomen in order to prevent hernia so must we drill the surgeon in the importance of covering fracture site and bony defects with periosteum in order to prevent non union. Therefore whenever it is necessary to operate upon a recent fracture the site of fracture is now always covered with periosteum after the reduction and

fixation have been attained. This periosteum can usually be obtained from the shaft adjacent to the fracture peeled off by a blunt periosteotome either completely or left attached at the margin nearest the fracture. It can then be wrapped about laid across and tucked in around the fracture site. It can be sutured to the periosteum on the opposite fragment or to adjacent soft tissue in order to hold it in place and sometimes the closure of the soft tissues over the transplant is all that is necessary. Case illustrating periosteal transplant in recent fracture.

CASE 1. J. A. colored male 22 years of age (case of Dr. Thomas A. Noble of Havana, Illinois) and operated upon at Ingalls Memorial Hospital) sustained a fracture of his right femur middle third on September 10, 1915. There was marked overriding of the fragment. A Thomas splint was applied with good mechanical traction for 2 weeks but without reduction. The patient was then anesthetized and strenuous effort at closed reduction was made but without success. The traction apparatus was again applied and maintained for 2 weeks but reduction was not obtained. At the end of 4 weeks of these efforts the patient was called upon to attempt the case. At operation the lower fragment was found displaced backward and upward (Fig. 1). A band of muscle lay between the fragments which may have accounted for the failure of closed reduction. It required considerable effort to secure a reduction and apposition of the fragments. They were held in end to end apposition by means of an internal splint consisting of an antemedullary beef bone peg. By the time the case was accomplished the adjacent fragments were fairly denuded of periosteum. A periosteal transplant was obtained from the right tibia consisting of a piece of periosteum approximately 6 inches long and 1/2 inch wide removed by a blunt periosteotome. As far as the naked eye could see no attempt was attached to the periosteum and its method of removal by blunt dissection precluded the removal of cortex. The splint of periosteum was then wrapped on and across the anterior surface of the fracture (Figures 2 and 3) showing the growth of the periosteum and the patient played in using apical union in this case. The patient was discharged from the hospital on December 26 and was walking without a crutch or cane by the 15th of January 1916. He made joint 3 months after the operation.

The next case illustrates the use of periosteal transplant in case of delayed union. Fewer cases of delayed union are being operated upon than formerly because there again experience is proving that massage passive

motion of adjacent joints and persistence in treatment will usually result in the desired end. Diathermy has seemed to be of value in a number of cases in which callus formation was unduly slow. But we occasionally have a case in which the delay in union threatens to give non union or in which the disability can undoubtedly be shortened by operative interference.

CASE 2. Miss DeY, 24 years of age (case of Dr. G. W. Walvoord of South Holland, Illinois) sustained a fracture of the right humerus middle third March 6, 1916. (The middle third of the humerus and the lower third of the tibia are two sites prone to delayed union in my experience.) The case was referred to the author's service at St. Luke's Hospital for operation on May 1, 1926. At operation the site of fracture was exposed and the fragments found to be approximated about one fourth of their circumference. The periosteum on either fragment was practically absent. No sign of callus was present. The fragments were brought into perfect alignment and held thereby with an internal splint of beef bone peg. This peg differed from the usual round peg. It was the author's triangular shaped peg with notches cut in one angular edge which enabled the pushing of the peg from the canal in the upper fragment downward into the intramedullary canal of the lower fragment more readily. A pure periosteal transplant was then removed by blunt dissection from the right tibia. This transplant 4 inches long and 1 inch wide was laid across the anterior surface of the humerus at the site of the fracture and sutured to the periosteum where it was intact on the humerus about 2 inches either side of the fracture. The interesting fact in this case is the development of new bone along this transplant so that the callus forms an arch over the site of fracture but no evidence of callus is present on the other surface of the humerus even 10 months after the operation was performed. In February, 1917, the X-ray examination shows this fracture united on the surface where the transplant was applied but still ununited on the opposite surface. Examination shows good strength even with this half union that is present. I believe this case is most valuable in proving the development of new bone from a pure periosteal transplant. A better and perhaps more rapid result would have followed the complete surrounding of the humerus at the site of fracture with the periosteal transplant (Figs. 5 and 6).

Better results from this method have been obtained in cases of ununited fractures than by any other method heretofore employed by the author. Thus far 30 cases of ununited fractures have been treated with or without internal splinting. In all of these cases union

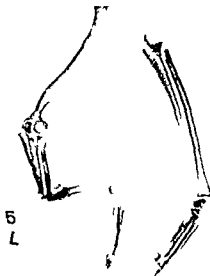
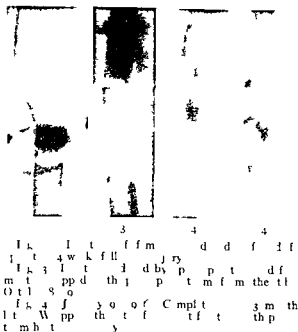


FIG. 1. Non union in dog 3 months after operative fracture in which periosteum was tripped from ends of fractured fragments. Note the bone regeneration occurring from the margin of the rolled up periosteum on the distal fragment and growing across the angle to unite with the proximal fragment.

has resulted. In one of these cases the beef bone pegs had to be removed later because of persistent infection and in one case the peg was removed because absorption of the shaft of the bone was threatening the desired end result. Latterly I have abandoned this method of beef bone peg internal splinting except in rare cases as will be explained later and the results are better.

CASE 3. S. G. male 25 years of age was referred to my service for operation for ununited fracture of the radius in November, 1924. He had been operated on by another surgeon some 8 months previously at which time a beef bone peg was inserted in the intramedullary canal of the fragments. This operation was performed 8 weeks after injury for delayed union. The X-ray picture taken at the time the case first came to my attention showed this peg in position but no evidence of union. At operation the site of fracture was exposed and the fragments of the radius were found completely denuded of periosteum. The ends of the fragments were found osteosclerotic above and osteoporotic below. The beef bone peg was holding the fragments in alignment and it showed very little evidence of absorption. The operation consisted of cutting away the ends of the fragments back to where fairly healthy bone was present. The peg was left *in situ*. The shaft of the upper portion of the radius was then exposed more thoroughly and from this a piece of periosteum about 1 inch wide and 3 inches long was raised by blunt dissection downward almost to the end of the upper fragment.



It is a flap of periosteum a ro the gap th b n i n l u r d to the p i teum on the lo v r fragm nt. By th man u r th tran plant as fr c at t u p p r n l a n l t t c h e l a d s e g a s h n g at its l r l a n d h n turned do n a r l th r r a m b i u m l a v e f the p e r o t u m f a c d u t a r d v th th u t r l a r o f p e i o s t u m x t t th b

In the discussion aroused when this paper was presented some doubted if periosteum turned upside down would grow bringing the old limiting membrane idea of periosteum to refute my claim. This maneuver has been repeated in other cases with the result that the periosteum does grow and even bridge over a bone defect. The case makes me feel that another law can be added to Wolff's law namely *New bone develops along the path decreed by the bone it is to replace and by the function demanded of it.* No limiting membrane necessary to prevent new bone growing wild or in any other direction than that demanded by the body function.

The subsequent X-ray picture taken of Case (Fig 7 b and c) show definitely that new bone development started along the upside down periosteal transplant and resulted in reconstructing completely the shaft of the radius.



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h m l m t k t t m f p t l f b p s
f t i p l t g d t l t l f f f
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l o e f r a g m t h s b r i n g g t h e s h f t s n t l g

ment and serving as internal splints. A small fragment of loose bone was found on the posterior aspect of the lower fragment of the radius and this was left in place. The right tibia was then exposed and a periosteal transplant the complete width of the tibia and approximately 5 inches long was removed by blunt dissection. A piece of fascia, approximately 2 inches wide and 5 inches long was removed at the same time and left attached to the outer border of the periosteal transplant thus forming a transplant composed of pure periosteum and fascia. This transplant was carried to the defect in the radius. The fascia was first sutured to the soft tissues in such a way as to form a fascial septum between the ulna and the radius. The periosteal portion of the transplant was then wrapped around the radius forming a bridge across the defect and covering about two thirds of the circumference of the radius. It was sutured above to soft tissues in close apposition to the bone and 2 sutures were applied below approximating it to the periosteum on the lower fragment.

The left tibia was then exposed and a similar periosteal transplant devoid of fascia however was removed by blunt dissection no cortex being obtained and was transferred to the defect in the ulna. This transplant covered approximately one half the circumference of the ulna and bridged across the defect in this bone. While an assistant was closing the operative wounds in both lower extremities the soft tissues were closely approximated about the repaired fractures in the ulna and the radius and the wounds were closed. The arm and forearm were encased in a plaster splint with the forearm flexed to approximately a right angle. Figures 10 and 11 show these fractures before the operation and 1 week following the operation. The progress of this case is illustrated by the subsequent roentgenograms (Figs 12 and 13). Union was slow because of the marked loss of bone substance in each bone which had to be filled in by new bone before union could occur. I believe that the progress was also delayed by the presence of the beef bone pegs which (Figs 12 and 13) caused considerable absorption of the cortex immediately adjacent to the pegs. Massage, passive motion and hydrotherapy were used continuously on this arm after the eighth week, great care being exercised not to disturb the fragments unduly.

On October 1, 1926, union seemed quite firm although the roentgenogram failed to show complete filling in of the defects. The splint was removed and the patient allowed to use the arm very slightly with the hope that function would stimulate further and more rapid growth of new bone. After 3 weeks it became evident that there was some false motion in the ulna. This was demonstrated by observing the arm under the fluoroscope. On November 1, 1926, I reoperated upon this case making an incision over the site of the fracture in the ulna. On the lateral posterior surface of the ulna there was a definite bridge of new bone com-

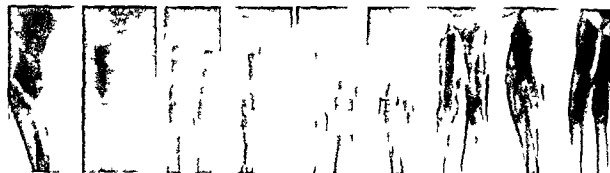


Fig 7 Ununited fracture of radius operated on November 3, 1924. Film taken November 30, 1924 showing periosteal transplant removed by blunt dissection from the proximal fragment and turned down and as on a finger bridging the 1 inch defect in the bone thus the periosteal transplant is up side down the inner layer pointing outward. The internal plant is a beef bone peg placed in the medullary canal 8 months previously.

Fig 8 Same case as in Figure 7, 6 months later. Note the thickness of the periosteal transplant showing that all of the regeneration has taken place in the transplanted periosteum.

Fig 9 Same case as in Figure 7 showing the completed reconstruction of the defect in the radius.

pletely across the defect but on the upper and inner surface no new bone was present and the beef bone peg lay in its bed completely exposed and easily movable. The radius was palpated through this wound and was found to be surrounded by a good callus and quite firm. The beef bone peg in the ulna was removed. The left tibia was again exposed and was found to be covered with a thick velvety periosteum which was thicker and richer in blood supply than the original periosteal transplant taken from this tibia. An osteal periosteal transplant the width of the tibia and 4 inches long was removed by blunt dissection along its lateral edges but by a chisel along its middle thus removing a thin piece of cortex with the transplant. This transplant thus consisted of an osteal periosteal graft with osteal substance along the middle of the transplant approximately $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness and pure periosteum along the margins. This was transplanted to the defect in the ulna. The osteal portion lying in the groove made by the removal of the beef bone peg and the periosteal portion wrapped about the upper and inner surface of the ulna. It was held in position by a few sutures in the soft tissues and to the periosteum on the fragments above and below. Figures 14 and 15 represent the growth of this osteal periosteal transplant and the subsequent repair in the defect in the ulna. The plaster splint was removed on December 27, 1926, and the patient was discharged with the ununited fractures completely healed and united on January 10, 1927, 14 months after my original operation for repair of non union in these bones fractures which had gone 13 months before this treatment was instituted.



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l te h th t tl d s h h more mpl t ly

3 u l l th p t l t n pl nt h d
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This case illustrates extremely well that *periosteum will form new bone and will bridge across even a marked loss of substance in the shaft that in the old case with changes in the bone characteristic of poor blood supply the beef bone peg can delay the healing process by causing bone absorption and that a more or less thin piece of cortex attached to a wide strip of periosteum furnishes a better method of repair.* The osteal portion of such a transplant can be made sufficiently thick to give substance and strength to the transplant thus furnishing a certain amount of internal splinting. The wide strip of periosteum attached to this narrower osteal portion can be wrapped around the shaft of the bone to be repaired thus furnishing more osteogenic tissue than is usually contained in the usual autogenous bone graft. While such a transplant may not have the finished mechanical touch of an autogenous graft cut by the twin saws yet it can be removed more quickly by blunt dissection and with a chisel and mallet and will contain almost 3 times as much periosteum as the autogenous graft cut by the former method. In my hand this method takes at least one third less time than I consumed in cutting and fitting my autogenous grafts.

While 14 months seems a long period for the repair of old ununited fractures yet it can be taken 2 years before complete union occurred in a somewhat similar case in which an autogenous graft was used. But the above case illustrates the chief point I am endeavoring to make viz that the pure periosteal transplants did form new bone and in the case of the radius bridged across a bony defect of approximately 1/2 inches.

CASE. R. A. male 18 years old referred by Dr. C. O. Wiltfong of Chesteron Indiana on October 2, 1925. This boy had suffered a fracture of the lower end of the shaft of the radius August 31, 1910. After repeated efforts to secure reduction it became necessary to resort to an open operation. The case was referred to another hospital in Chicago September 6, 1921 and one of the surgeons operated attaching a Lane plate to the shaft of the radius in order to hold the fragments in apposition. The boy made a good recovery from the operation and 1 year later the union had apparently been secured by the end of 5 months. All splints were removed and he was allowed to use the arm freely. He had no trouble with the member until nearly 3 years and 9 months later while playing in the school yard he seemed to feel something give in this arm. He had no pain but shortly thereafter a slight swelling developed. Dr. Charles H. De Witt of Alhambra made an X-ray examination which showed that the Lane plate had loosened and there was either a non-union or a non-union at the site of the old fracture. A full length of motion

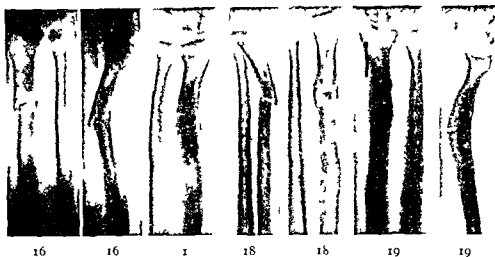


Fig. 16 Ununited fracture of radius of 3 years duration. Operation: Lane plate removed, fragments adjusted and strips of periosteum removed by blunt dissection from the proximal fragment and turned down and across the site of the fracture forming a periosteal bridge chiefly along the lateral surface. First film was taken 1 week after operation.

Fig. 17 Same case as in Figure 16 taken 16 days after operation. Note the growth of the periosteal transplant.

Fig. 18 Same case as in Figure 16, 18 months after operation. The periosteal transplant has fused with the shaft. Note that the regeneration of the bone is best at and near the transplant.

Fig. 19 Same case as in Figure 16 showing a green stick fracture at this site 11 months after operation for ununited fracture. Note that the new bone along the lateral margin where the periosteal transplant was applied is the only portion of the shaft not refractured.

could be easily demonstrated. The case was brought on September 7, 1915 to Chicago but as the original surgeon had moved to another city the boy was entered on my service at St. Luke's Hospital. At operation one of the screws from the Lane plate was found lying in the soft tissues and the other screws loosened up so that the plate was easily removed. The fragments below the plate and about the site of the fracture were denuded of periosteum. The ends of the fragments were osteoporotic. This softened bone was removed thereby freshening the ends of the fragments. They were in very good alignment and no effort to change the alignment was made. The shaft of the radius above the site of the fracture was exposed and a strip of periosteum was removed by blunt dissection and turned down across the site of the fracture. Great effort was made to secure an abundance of periosteum across this defect in the bone and some of the strips were therefore turned down so that the cambium layer pointed outward. The anterior surface of the bone alone was covered however. Figures 16, 17 and 18 show the rapid healing which occurred in this old fracture. From the findings at the time of operation this was definitely an ununited and not a recent fracture. The fracture had never united under the Lane plate. The boy was discharged 10 weeks after the operation with firm union.

Since writing the foregoing we have had an extremely interesting additional observation in this case. On September 8, 1927 while playing ball

the patient fell striking on his extended right hand. He immediately felt pain at the site of the old fracture and observed an angulation deformity. Swelling of the forearm rapidly followed. He was again taken to Dr. De Witt of Valparaiso, Indiana who examined the arm with the X-ray and diagnosed a fracture at the site of the old fracture. He was sent at once to my service at St. Luke's Hospital. Examination showed a slight angulation, slight swelling and point of moderate tenderness directly over the site of the old ununited fracture described above. Study of the roentgenogram which he brought with him and of a second film taken 3 weeks later (Fig. 19) showed the following: There is a line of fracture through approximately two thirds of the shaft of the radius resembling a green stick fracture. The unfractured portion of the radius consists of one third of the lateral portion of the cortex where the periosteal transplant was placed across the site of the old fracture just 11 months previously. This unfractured portion shows strong healthy bone but slightly bent. The margins of the fragments of the fractured portion and the shaft above and below this fracture are somewhat osteoporotic and you can still see drill holes used for the Lane plate 4 years ago. In other words firm union of this old ununited fracture resulted along the anterior margin where the periosteal transplant was laid but that portion of the shaft which was not covered by the transplant showed poor osteogenesis.



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m. d. a. d. t. d. d. p. l. d. f. m. th. p. m. l. f. g.
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Fig. 2. S. m. a. as. n. F. h. g. th. f.
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This case as well as Case (Figs 5 and 6) demonstrate conclusively that a pure periosteal transplant containing no cortical bone substance whatsoever will grow and form new bone. Study of these roentgenograms shows that this new bone involves the cortex immediately under the periosteal transplant however in the portion of the shaft not covered by the periosteal transplant new bone did not grow so that there was a partially ununited fracture of the shaft. I have not observed this condition in any of the other cases yet these two cases enable us to arrive at the following conclusions:

1. The periosteal transplant will form new bone but it may be limited only to that portion of the shaft covered by the transplant.

2. To insure complete union in an ununited fracture at least two third of the shaft at the site of fracture should be covered by the periosteal transplant.

3. More rapid and more complete healing of the ununited fracture will result if the

shaft at the site of the fracture is completely surrounded by periosteal transplant.

CASE 6. J. T. male of Belmont W. consin 38 years of age. In March 1923 this patient as in an explosion and suffered a severe compound fracture of the upper third of the right leg. The soft tissues were badly lacerated and a fragment of approximately 3 inches long was blown from the shaft of the tibia at the junction of the middle and upper third. Considerable doubt existed as to whether the leg should be amputated. The patient was called to see the case a few days later and advised by Dr. Benjamin Fosse that his treatment of debridement followed by the Carrel-Dakin method of irrigation was justified and might result in saving the limb. A very marked infection developed which persisted for a week. Eight months elapsed before we felt it was safe to attempt repair of the substance in the tibia. Figure 3 shows the condition of the tibia at that time.

On April 3, 1924 the author went to Belmont and operated upon this case with Dr. Fosse. Operation consisted of freshening the upper fragment of the tibia and cutting away the osteoclast position of the lower fragment of the tibia. This left a gap of approximately 4 inches to be filled. A discharge still persisted from the wound at the

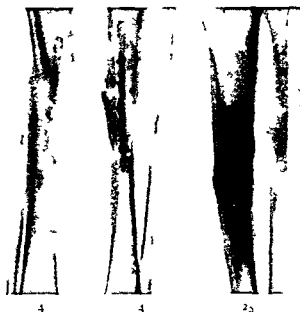


FIG. 24. Unreduced comminuted fracture of the tibia and fibula operated upon weeks after injury. Operation fracture reduced and held in alignment by beef bone peg intramedullary plant the fracture site then covered by periotéal transplant removed and turned downward from the proximal fragment of the tibia.



FIG. 25. Same case as in Figure 24 showing the repair of the fracture and almost complete absorption of the beef bone peg 3 months after operation.

FIG. 26. Same case as in Figure 24 taken 10 months after operation. Patient has been working for 3 months complete restoration of function.

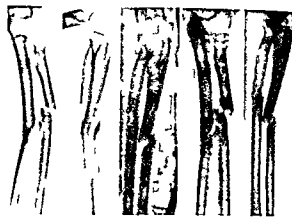
soft tissue and therefore a complete removal of old infected tissue in the neighborhood of the fracture was made at this time. A beef bone peg was inserted in the medullary canal of the lower fragment of the tibia and worked upward into the medullary canal of the upper fragment thus forming an internal splint which held the tibia in proper alignment. Next a strip of periosteum 3 inches long and the entire width of the upper fragment of the tibia was removed by blunt dissection downward but left attached at its lower margin and turned as on a hinge downward over the defect in the tibia. Strips of periosteum were next removed from the anterior surface of the lower fragment of the tibia and were laid across the defect. Soft tissues were closed over the defect as well as possible but complete closure could not be secured because of the amount of tissue which it was necessary to dissect away because of the old infection.

Patient made a slow but progressive recovery and the growth of new bone from these periosteal strips is well illustrated in Figures 20, 21, and 3. The soft tissues closed over the area except for one small persistent sinus. Solid union had occurred in this case by January 1926—1 year and 8 months after the operation. At this time the sinus would remain closed for a few weeks and then would open but with very little discharge. Since the patient was at work and was getting along very well it was my judgment that this condition should be left alone for at least 6 months more, fearing a recurrence of the infection if another operation was attempted too soon. In June 1926 however I was called in consultation on this case by the insurance company with another surgeon of Chicago. This surgeon

felt that the case should be reoperated upon at once and the beef bone peg removed. A week later I was told that this surgeon had removed the beef bone peg. I have learned that the old fracture showed good union but that the beef bone peg was lying loose in the medullary canal with softening of the bone immediately in the neighborhood of the peg. His operation consisted simply of removal of the peg and curetting away the soft portion of bone in the neighborhood of the peg. The wound healed and the patient was discharged from the hospital in 4 weeks. Patient now has good firm union with out any evidence of infection and approximately 75 per cent of function in the knee joint.

Observation of a series of 5 X-ray films taken on this case from 3 weeks after my beef bone internal plating periosteal transplantation to June 1926 a little more than 2 years after the operation again demonstrates that perio bone will grow and form new bone.

If I were operating upon this case today instead of using the beef bone peg I would use an oteal periosteal transplant as described under Case 4. This case however does illustrate that the restoration of periosteum across the marked defect in the tibia resulted in regeneration of bone and closing in of the defect. It is my judgment that the defect closed more rapidly than would have been the case if I had used a narrow autogenous bone graft containing only a small amount of periosteum. Further the cutting



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of such bone graft in an area where infection had been rampant a few months before would have made recurrence of the infection more probable

CASE. D B male 43 yr old ef red to my s r i at St Luk Hospital D Nobl Har ey Ill no n n v mb o s b ause of an un r d d frater f th l f t b nd fibula j t bul the mille thur l Th njury occ rred O t b r o o s a d v f f r t h d been m le to u u n b v th c l s l m thod At operation I found a th k fibro s b l b t en th fragm nts of the tibia m p o d f n t r p o g s f t t suc and nb ou t ue h t r t i of non union Th s v a cut a v an l th l f the fragm t fr sh ned Th alig m n t n l app t i n m al by an nt ame lull b f b o p g used as h e splint A p o t a l t r p l t as th n moved f m th p p r p o r t i of th ha ft of th tibia on t g of th lth f th t b a a d about 4 inches in l gth a d a v e f u l l w a p p d and utur d about the t f f a c t u r e F g u e s 4 5 an l 6 h th ub que t developm nt of bo e an l u n o n of th fr t u e n t h i c a s e

Six of the case in which perio teal trans plant have been used have been in old fracture of the tibia In all but 2 of these I have been able to notch the upper fragment and sharpen the lower fragment in such a way that it fitted into the notch thus giving apposition and a certain amount of fixation without using any foreign material for fixation The method of external fixation by splinting and by circular band of plaster of Paris described at the end of this article has obviated the need of internal splinting in the majority of my cases In 1 of the cases the defect was covered by periosteum secured from the adjacent shaft and fixation secured by 2 Putti band which were later removed Whenever Putti or Farham Martin band are used great care should be exercised to see that the e are applied around the bone outside of the periosteum and not next to the bone denuded of periosteum In another case in which internal fixation was necessary I chiseled a narrow rather thick piece of cortex from the adjacent shaft to which was attached wider portions of pure periosteum This

osteal portion formed the internal splint while periosteum furnished the osteogenic tissue

CASE 8 F F male 30 years of age referred on January 17 1927 for reconstructive operation on his foot. Eight months previously he had suffered a fracture of the first second and third metatarsals of the right foot. These had united but patient complained of severe pain in the sole of his foot when walking or standing. Examination showed the proximal portion of the first metatarsal was displaced backward and into the sole of the foot. It was undoubtedly due to pressure on this displaced proximal fragment. At operation incomplete union of this fracture was found. The proximal fragment was so badly displaced that the deformity could be overcome only by complete removal of this fragment. The removal of this left the joint surface of the scaphoid bone exposed with a gap of approximately 2 inches between it and the distal fragment of the first metatarsal. A periosteal transplant was removed from the right tibia with a small piece of fascia attached to its outer margin. This fascia was sutured to the soft tissue so that it formed a cap over the joint surface of the scaphoid. The periosteum was rolled into a tube and sutured to the periosteum of the distal fragment and to the soft tissues in the sole of the foot thus forming a pure periosteal transplant across the defect in this metatarsal. Figures 27 and 28 show the rapid development of new bone which filled in the defect and resulted in a complete cure in this case.

CASE 9 G W female 35 years of age operated upon at Gary Indiana with Dr Ira Miltimore on July 15 1927 had suffered fracture of both bones of the forearm middle third some 8 months previously. Several attempts at reduction were made and fair alignment of the fragments was finally attained. The fragments were immobilized with mechanical rather than plaster splint and immobilization was very imperfect. At the end of 6 months the case was referred to Dr Miltimore. He attempted by closed reduction and immobilization to secure union and by the end of 2 months it was evident that permanent non union existed. At operation the sites of fractures were exposed by two incisions the ends of the fragments freshened and attempt to wedge them together by notching made. No internal splint was used. The absence of all periosteum about fractured fragments was definitely noted. A large strip of pure periosteum was then removed by blunt dissection from the right tibia and this was divided equally into two parts one portion of periosteum was wrapped approximately one half way around the shaft of the radius and the other portion about the shaft of the ulna at the site of the fractures. The wounds were then packed and a plaster splint with circular bands of plaster of Paris bandages applied for external splinting as described below. Sterile gloves and gowns were then again put on by the operator and his assistant the splint in the neighborhood of the

wounds carefully covered by sterile towels and the packing then removed from the wounds for inspection. Slight adjustment was necessary to secure fair anatomical alignment of the fragments soft tissues and skin was then closed. This patient now has union of both fractures (November 1 1927). Figures 29 30 and 31 show the growth of the periosteal transplants.

INTERNAL VERSUS EXTERNAL SPLITTING

Before granting the value or superiority of such a transplant as this thin soft periosteal tissue the question of fixation and alignment of the fractured fragments must be met. If we will acknowledge that the periosteum on a complete bone graft is the chief osteogenic layer of the graft then the chief function of the cortex or firm bone of the transplant is to act as an internal splint to bridge across the defect holding the two ends fixed and in alignment. In the majority of cases this cortex splint must be held in close approximation and fixation to its host by some foreign material such as chromic catgut or kangaroo gut autogenous or ivory peg wire etc. Groves seems to favor a peg or wire as firm fixation is of prime importance and he states that when a peg is used dead bone is of equal value to an autogenous bone peg.

Since foreign material must be included so frequently with the autogenous bone graft then why should we not resort to some form of foreign material as a means of internal splinting and fixation of the bone fragments combined with the easier obtained and far superior large periosteal grafts. In many cases the fragments can be held in approximation and fixation by the use of external plaster of Paris splint with plaster of Paris encircling cast above and below the defect or the fragments can be impacted after freshening or even held by kangaroo gut and then the defect wrapped with the periosteal graft. But when this is impossible or there is a considerable loss of bone substance to be bridged then either a cortical graft must be used or a foreign material substitute employed.

Following the above reasoning I began the use of beef bone pegs as a means of internal splinting when necessary some 4 years ago. Recognizing that the round beef bone peg filling the entire medullary

canal frequently resulted in absorption of the cortex adjacent to the peg. I had made a triangular beef bone peg which came into contact with the medullary canal at only 3 points. This peg has absorbed more rapidly than the round peg and has caused less bone absorption. A number of methods have been devised for pushing or pulling the round beef bone peg from the intramedullary canal of one of the fragments downward or upward into the medullary canal of the adjacent fragment. The method usually used is that of clamping a small window in the shaft of the upper fragment, inserting a pair of artery forceps and grasping a suture threaded through the end of the beef bone peg already inserted in the opposite medullary canal. Traction upon this suture then pulls the peg upward or downward into the adjacent canal. This technique adds considerably to the length of the operation. To overcome this objection I had the triangular beef bone peg notched. A small spatula could then be

slipped between the approximated fragments grasping these notches each in turn and shoving the peg upward or downward into the adjacent canal. This overcomes most of the difficulties of inserting a beef bone peg.

Years ago I gave up the use of Lane plates of wire and of other metallic material as a means of internal fixation due to three facts: first, the presence of these metallic substance frequently resulted in bone absorption; second, it was frequently necessary to remove them; third, in the majority of cases some better method of fixation could be secured. The same objections can be applied to the use of the circular beef bone peg and also to the triangular peg. I have been forced to remove two beef bone pegs and another surgeon has removed one of the pegs that I have inserted. And careful observation of the X-ray reproductions in this article shows that in a few cases bone absorption has occurred. Therefore I am less and less prone to use any method of internal fixation except the osteoperiosteal graft when there is considerable bone defect. In all other cases I have found external plinting sufficient.

In all cases of open reduction of fractures or of operation on old ununited fractures I

am now using the following plan of external splinting. After the operation is completed on the bone proper and before the soft tissues are closed over the repaired fracture the wound is carefully packed and protected from contamination. While this is being done an assistant is molding a plaster of Paris splint of the desired length for the extremity. One layer of thin sheet wadding or often no padding at all is used. The splint is then applied directly to the limb opposite the operative wound. The splint is fixed to the extremity by a few turns of a circular plaster of Paris bandage applied in the case of a leg first about the thigh then just below the knee above the site of the operative wound. Another circular plaster of Paris bandage is thrown around the splint and lower extremity just below the operative wound. Only one or two turns of this plaster bandage is applied below at this time. During the application of this splint and circular bandage an assistant has held the extremity in proper position to maintain the apposition and alignment of the fragments. The operator and one assistant now put on fresh sterile gowns and sterile gloves, clean linen is put under and over the extremity and sterile towel are packed carefully into the margins of the splint so that the packing in the operative wound can now be removed leaving the operative field sterile. The repaired site of fracture is carefully inspected and any slight readjustment of the fragments that is necessary is made. This can all be done before the splint has become too hard for slight readjustments. By actual inspection the operator now knows that he has his fragments properly aligned and while the assistant holds the extremity until the splint becomes hard the soft tissues and skin can be closed by the operator. The splint can now be strengthened by further plaster of Paris bandages.

This patient can be returned to his bed and X-ray pictures taken the next day and in every case thus far the fragments have been in exactly the position arranged at the operation. This inspection method is so simple that one wonders why we have always closed our wounds in the past and then

applied our circular casts or splints constantly dreading that the fragments would slip and often finding when the X ray picture is taken that they have slipped necessitating further operation or manipulation

CONCLUSIONS

1 The consensus of opinion of practically all investigators on the subject of How Does Bone Grow? indicates that periosteum of all the three bone layers contains the chief osteogenesis

2 Pure periosteal transplants containing no cortical substance whatsoever in the cases herein reported have resulted in union of fractures in delayed union in repair of ununited fractures and in bridging across large bony defects. Studies of the serial X ray pictures in each case show the new bone formation starts and continues from the transplanted periosteum

3 Experience in this method has taught that best results are obtained the more completely the shaft at the site of the fracture is covered by the periosteal transplant. In the neighborhood of these old fractures especially with non union the adjacent fragments are practically always completely denuded of periosteum. Therefore the aim of this transplant is to replace as nearly as possible this osteogenic layer

4 External splinting as a method of hold-

ing the fragments in alignment is far superior to any method of internal splinting or fixation by means of foreign material such as Lane plates wire beef bone pegs etc

5 When there is considerable bony defect which must be bridged the autogenous graft or better the osteal periosteal transplant is probably superior to the pure periosteal transplant

6 Whichever method bone graft osteal periosteal or pure periosteal transplant is used more rapid and better results will be obtained if a large piece of periosteum is employed to surround most of the shaft at the site of the defect

7 In practically every case in which an autogenous bone graft is indicated the same repair can be obtained more rapidly and with less trauma to the tissues by the use of an osteal periosteal or pure periosteal transplant

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EXPERIMENTAL STUDY OF THE FACTOR OF BILIARY STASIS IN THE PRODUCTION OF GALL STONES¹

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AND

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S I S H I T H A C T I S I C T B I I I D

STASIS of bile in the biliary tract has long been considered a predisposing and exciting cause of gall stones. Attention has recently been called anew to this factor by the experimental work of Whitaker who has produced gall stones in cats by the stagnation of bile alone. To induce stasis of bile in the gall bladder he cut and dilated the sphincter of the common bile duct of the cat a procedure which has been shown to prevent reilling of the gall bladder. Nine hours afterward the cat was given a fat meal to cause partial emptying of the gall bladder and was then starved for several days when autopsy showed a stone apparently a cast of the shrunken gall bladder.

Production of stones in the gall bladder by stasis alone seemed so striking that we have repeated and extended the experiments of Whitaker. His technique for the production of stasis by cutting the sphincter was carried out on 18 cats. In many of the experiments described by Whitaker iodized oil was introduced into the gall bladder to demonstrate the stasis of bile. To eliminate this factor which we thought might play some part in the process described by Whitaker the iodized oil was injected into the gall bladders of only 7 of the 18 cats. In the gall bladders of the 11 cats in which stasis had been produced but no iodized oil injected there was not the slightest trace of the formation of stone. Six dogs similarly treated likewise did not show stones. Of the 7 cats in which iodized oil was injected into the gall bladder 3 had semi solid masses resembling the stone described by Whitaker. As iodized oil seemed to be the deciding factor in the production of these masses another series of experiments was performed in which no stasis was produced. Iodized oil was merely injected into the nor-

mal gall bladder. Similar masses were sometimes found in these gall bladders although no stasis was present. These experiments seem to indicate clearly that the iodized oil rather than stasis was the important factor in the production of the so called gall stones.

The semi solid masses which were produced in the gall bladders containing lipiodol seemed to be similar to those described by Whitaker. These masses have little resemblance to human gall stones. They are greenish black soft and homogeneous varying in size sometimes occupying the entire gall bladder. Examination shows the presence of fat globules in the specimens. We were inclined to think at first that soaps were present but chemical examination did not confirm this. Cholesterol was not found which again strongly suggests that they bear little relation to human gall stones but instead result directly from the presence of iodized oil.

Believing nevertheless in spite of our negative experiments that stasis is undoubtedly one factor in the production of gall stone in man we performed experiments in which stasis of the bile was associated with another important factor infection. Stasis of bile was produced in cats after the method of Whitaker by cutting the sphincter of the common bile duct. Stasis was produced in dogs by another method which insured complete stagnation in the gall bladder and yet did not cause obstructive jaundice. This is made possible by the anatomical arrangement of the ducts in the dog. Two lateral hepatic ducts join the common bile duct at a considerably lower level than the junction of the middle hepatic and cystic ducts. The common bile duct can therefore be ligated in its upper part so that the middle hepatic duct drains only into the gall bladder from which emptying is prevented by the ligature. This technique in ure complete stasis in the gall blad-

Wh A I R Th m h m f h H B J I I I to
h l i h a s J A m M A 9 I 5

F m h D p r t m e n f e r y W h g t U r s y M e d I S c h o o l d B r u n e l H o s p i t a l

der and at the same time maximum concentration of bile

Simultaneously with the production of stasis by these methods in cats and dogs organisms were introduced into the gall bladder bacillus coli staphylococci and streptococci being used. The animals were sacrificed after periods varying from a few days to several weeks. Neither cholelithiasis nor chronic cholecystitis was thereby produced in any instance.

Experiments were then performed in which substances which might serve as nuclei for stone formation were placed within the gall bladder where stasis of bile had been induced. In some instances infection of the bile was added. Tissues of parenchymatous organs fragments of metal gauze calcium lactate cholesterol lecithin and colloidal substances were used. No stones were formed under any of these conditions. In one cat however in which a piece of gauze infected with bacillus coli was inserted into the gall bladder a marked degree of chronic cholecystitis resulted.

In another group of cats the sphincter of the common bile duct was cut and the walls of the gall bladder in some instances the mucosa and in others the serosa were thoroughly cauterized with phenol. Autopsy of the ani-

mals after varying lengths of time did not reveal any stones.

As another point against the importance of stasis as the sole factor in the production of stones is the fact that those individuals whose bodily constitutions are associated with the greatest amount of stasis in the gall bladder namely the visceroptotics are not so likely to have stones as the short obese type. This point is elaborated in a paper by Sherwood Moore now in press.

SUMMARY

Clinical opinion has suggested the importance of stasis of bile infection and the presence of nuclei in the gall bladder as factors in the production of gall stones in the human. We have not been able however to induce cholelithiasis in experimental animals by either stasis alone or by stasis combined with infection of the bile even in the presence of various foreign bodies. Obviously other conditions seem necessary for gall stone formation. A likely factor may be intramural infection especially since clinical investigation by one of us¹ has shown its frequent presence in cholelithiasis even when the bile is sterile.

ILLINGWORTH C. F. W. Type I gall bladder fistula

FACTORS INFLUENCING PROGNOSIS IN CARCINOMA OF THE RECTUM¹

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I m h D I n g r y d t h S e c S g I P t h l g y M j C l

INFLUENCES which favor or prejudice the successful outcome of the surgical treatment of rectal or rectosigmoid carcinoma readily divide themselves into two groups—extrinsic and intrinsic. The extrinsic are modifying influences such as age, general condition of the patient, duration of the lesion with its attendant signs and symptoms, and various local conditions associated with the neoplasm, such as its size, situation and mobility, the presence or absence of metastasis, both lymphatic and visceral, fibrosis, lymphocytic infiltration, and hyalinization. The intrinsic influence with its attendant effect on extrinsic influence is represented by the activity of the cancer cells themselves. From the surgical standpoint, extrinsic factors, except such elements as age and such general evidence of resistance as the extent of local resistance expressed in terms of fibrosis and so forth, determine the so-called operability of each case. This controversial appellation implies conditions favorable and unfavorable to the removal of cancerous growths, conditions which in borderline cases must be measured and evaluated by the judgment, experience, and courage of the surgeon.

Nowhere is there any dissension from the dictum that metastasis to the liver rules out radical resection, except in the small group of cases in which removal of the growth with restoration of the lumen of the bowel seems advantageous as a palliative measure.

Fortunately, one may resect portions of the prostate gland or seminal vesicle or perform hysterectomy in the course of an operation for extirpation of rectal carcinoma with relatively satisfactory mortality in certain selected cases. Whether or not the high mortality and morbidity and end results in this particular group of cases warrant radical operation is extremely questionable and one wonders (considering the fact that many patients suffering from inoperable carcinoma of the rectum who have been subjected to palliative

colostomy enjoy a relatively satisfactory existence for 1 or 2 years) whether extensive technical feats which unquestionably produce prolonged disability are compatible with sound judgment. Occasionally one of the extremely radical operations is followed by prolonged freedom from recurrence and encourages the practice of attempting to remove large fixed carcinomata, but if the sacrifice of important organs is necessary in the course of the operation, more often than not such results in high immediate mortality and early recurrence. In the light of comparative results with other therapeutic agents, however, the suppression of carcinoma calls for extension in the scope of operability.

Undoubtedly, the best prognosis in the surgical treatment of rectal carcinoma attend that very favorable group of cases in which operation may be performed early and in which the growth is not fixed, has not involved the lymphatics, and is found on resection not to have invaded the musculature of the colon. In this group of cases the operative mortality is extremely low for any type of resection and the percentage of cures is very high. We have not grouped our cases as favorable and unfavorable but taking the cases which have been subjected to resection as a routine, we find that in approximately half of them there has been no recurrence at the end of 3 years, and in a third the patient is alive and free from recurrence at the end of 5 years. The operative mortality in the whole group for the double operation of colostomy and posterior resection was approximately 6 per cent.

Our rule in cases in which metastasis to the liver has not occurred is to attempt the resection of the offending growth in every case if it is not wholly immobile from fixation to adjacent organs.

Fortunately, metastasis is a slow process and even lymphatic involvement does not take place rapidly. The first recurrence after operation is usually noted in the liver. Death

TABLE I—GRADE OF MALIGNANCY AND METASTASIS AT OPERATION

	C 1	C 2	G 1 3	C 1 4	All grades
P t t w t h m t t	(6 8 " f 9)	9 4 (3 " f 90)	77 (50 " f 37)	33 (1 7 f 5)	60 (46 " f 56)
P t t w t h m t t m t a s t a s	60 (71 " f 8)	(55 " f 90)	60 (43 " f 37)	8 (5 0 f 5)	300 (53 " f 560)
Lymph nodes m e d	82	9	37	5	
Lymph nodes t m e d	3	9	4		
T t a l	(7 55 " f 59)	90 (5 00 " f 59)	4 (3 57 " f 59)	53 (8 86 " f 59)	

*O tag type f p e t Q T t t l H s o C 1 p

from metastasis to the liver is puny in the majority of instances in marked contrast to the long drawn out suffering which accompanies ulcerating adherent and inoperable growths. Sepsis from these huge foul surfaces rather than metastasis is the cause of death. Local fixation unquestionably is the cause of refusal of radical operation more frequently than internal metastasis.

The inadvisability of excluding the possibility of metastasis is evidenced by the fact that many times one feels that the hard lymph nodes in the immediate vicinity of the growth are an evidence of extension of the carcinoma. However this may frequently be proved erroneous by microscopic examination and it is unwise to assume from palpation that all lymph nodes are cancerous many nodes will be found on more careful examination to be inflammatory and the possibility of radical operation will not be excluded.

The duration of the growth and its situation influence the surgical outlook enormously. It is a difficult problem to fix the exact duration of symptoms and signs in a case of rectal carcinoma since at the time the patient appears for treatment symptoms and signs have been present for many months and not infrequently for years. In the average case of rectal carcinoma observed at the Mayo Clinic symptoms have been present for more than a year. Since the signs and symptoms always consist of blood in the stools change in bowel habits or some obstructive phenomena the growth must have progressed to the point of ulceration or occasionally to subacute obstruction before the patient is aware of its presence. The type of growth influences the duration of symptoms and signs depending on whether it is a rapidly progressing

cellular carcinoma or a more slowly growing type.

The situation of the growth is of importance from the standpoint of prognosis because the pathological types vary in different parts of the rectum and because of the influence on the time at which symptoms and signs appear. Most growths in the rectum occur in its ampullary portion or higher at the rectosigmoidal juncture. The smallest percentage of growths are in the anal canal and around the external anal orifice. The latter growths are usually epitheliomata and can always be recognized by the most superficial general examination. It seems entirely reasonable that they should be observed in their earliest stages. On the contrary however many cases of several years duration are on record. The lymphatic drainage in this area is forward into the groin rather than retroperitoneal and lateral as it would be were the growth higher but in any event once the lymph nodes in the groin are involved radical operation is useless and the prognosis is hopeless.

Rectosigmoidal growths are not readily felt by the examining finger but occasionally they telescope themselves into the ampulla of the rectum and may be palpated easily. The difficulty of determining the exact situation of the growths by proctoscopic examination is demonstrated in this class of cases in which operation sometimes reveals the growths at or above the rectosigmoidal juncture although they have been observed physically well down in the middle of the rectum. In women growths in this situation are usually palpable through the vagina particularly if fixation has occurred since the tendency of a growth in the lower part of the sigmoid is to drop down into the cul de sac and fasten itself onto the

TABLE II—GRADE OF MALIGNANCY AND RESULT OF OPERATION

	C 1	C 2	C 3	C 4	All
1 f m	(00 f)	7 00 f	9 00 f	(08 f 51)	
L	5 56 f	8 00 f 9	(5 00 f 3)	8 (5 3 f 5)	
I f m	5 7 00 f 3	8 f	5 7 00 f 5	7 (5 9 f 8)	
I f m	8 00 f	8 (6 8 00 f 55)	(74 8 00 f)	(86 5 00 f 5)	
I f m	56 f	(00 f 55)	87 (00 00 f 18)	35 (5 00 f 7)	
T 1 00 f	9 00 f 8	(00 f)	(7 00 f)	9 (00 00 f 5)	5 (6 00 f 5)
T 1 00 f	8 8 f 8	00 f 7	8 (00 f)	6 (8 00 00 f 5)	306 (58 7 00 f 5)

posterior wall of the uterus. Recto sigmoid growths require an abdominal type of operation which is a more formidable procedure than posterior resection following colostomy and yet because of their early obstructive signs they should be recognized in an earlier stage than the lower growth of the rectum proper. By using a graded operation which consists of colostomy and an interior type of resection one of us (Franklin) has removed the recto-sigmoid and rectum down to the anal canal in a series of consecutive cases with but 1 death. This reduction in mortality has been due to several factors the most essential of which are adequate pre-operative preparation and the use of spinal anesthesia. The operation permits wide removal of the lymphatic structures and the remote results should be satisfactory. If the growth is situated in the middle or upper portion of the

rectum extirpation by either the graded operation of colostomy and posterior resection or the abdominoperineal type of procedure as advocated by Jones or Miles may be carried out with low mortality and satisfactory end results.

Age is another factor which influences prognosis is most emphatically. Fortunately the average age in case of carcinoma of the rectum is more than 50 years. Most of the patients at the Mayo Clinic have been between the ages of 45 and 60 and most satisfactory end results have been obtained by radical operation on the elderly patients. There is ample clinical evidence to the effect that the prognosis in rectal carcinoma in the earlier decades is highly unfavorable. Unfortunately there are a great many cases of carcinoma of the rectum in patients between the age of 40 and 50 and even below 40. The active tissues

TABLE III—METASTASIS GRADE OF MALIGNANCY AND RESULTS

	C 1	C 2	C 3	C 4	All grades
P h m	8 00 f 60	8 00 f 60	(6 00 f 60)	(60 00 f 6)	
I f	00 00 f	(00 00 f 8)	(00 00 f 77)	(00 00 f)	
L	8 00 f	6 (3 00 f)	(00 00 f 77)	(3 00 f 3)	
(00 00 f)	00 00 f 7	3 00 f	(00 00 00 f)	(00 00 f)	
D 1	68 00 f	7 6 00 f	66 (8 00 f 7)	(6 00 00 f)	
(00 00 f)	00 00 f	(3 76 00 f 18)	5 (00 00 f 5)	6 (00 00 f 6)	
I f m	3 (00 f 3)	(5 00 f 7)	3 00 f		8 (3 00 f 3)
T 1 00 f	(00 f)	37 7 35 00 f	60 7 00 f 7	7 (00 00 f)	8 (3 00 f)

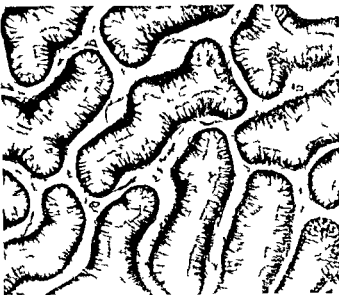


FIG. 1. Adenoma in which the cells are practically completely differentiated for this reason it is called benign.

of youth instead of resisting cancer invasion invite its spread and the young person who is host to a malignant neoplasm has little chance for longevity regardless of the type of therapeutic measures instituted. The lymphatic senescence and tissue inactivity common to advancing years offer a much more satisfactory first line of defense than the vital elasticity of youth.

PATHOLOGY

Carcinoma of the rectum like carcinoma of other parts of the gastrointestinal tract is usually of the adenomatous or gland type occasionally a squamous cell epithelioma or epidermoid carcinoma is found but it is usually situated at the anus. When a squamous cell epithelioma is found above the anus its origin



FIG. 2. Adenocarcinoma "graded 2" in an adenoma. The cells in the acini in the upper left hand corner are practically completely differentiated while those in the acini in the right and lower part of the section are not the latter are therefore cancerous.

is explained in the same way as that of epithelioma of the stomach and gall bladder the regenerative cells of the glandular epithelium in these organs have the power to produce either a secretory (glandular) epithelium or a protective (squamous) epithelium. In this series of cases there was also one melanoma epithelioma situated just inside the anus this is rare in the rectum. Adenocarcinoma of the rectum like carcinoma of other parts of the intestinal tract presents different gross forms papillary polypoid mucoid ulcerating infiltrating napkin ring and so forth. It is also liable to infection and degenerative processes as well as to ulceration. Microscopically the cells of adenocarcinoma of the rectum may be

TABLE IV — ABSENCE OF METASTASIS GRADE OF MALIGNANCY AND RESULTS

	C d	G d	C l 3	G d 4	Alg l
P t t w f m t t	60 (00 ^{cr} f 3)	6 (54 00 ^{cr} f 300)	6 (00 f 3)	3 16 (f 3)	
I f m t	58 (96 66 ^{cr} f 6)	58 (97 53 f 6)	58 (96 66 ^{cr} f 6)	7 16 ^{cr} f 8)	
L Good l l t	3 (55 7 ^{cr} f 58) 3 (93 75 f 3) (6 5 ^{cr} f 1)	7 (46 83 ^{cr} f 58) 7 (97 9 f 74) (7 f 74)	4 (4 37 ^{cr} f 58) 3 (95 8 ^{cr} f 4) (6 ^{cr} f 4)	6 (15 f 7) 6 (^{cr} f 6)	
D d (od l t P l t	6 (44 8 ^{cr} f 58) (3 3 ^{cr} f 5) 3 (86 66 ^{cr} f 5)	84 (53 6 f 58) (7 6 f 68) 50 (8 35 f 68)	34 (59 64 f 57) (4 00 ^{cr} f 4)	(6 7 ^{cr} f 7) (8 8 f 1) 9 18 8 f 1)	
T t l good es l t	3 (69 08 ^{cr} f 7)	84 (59 5 ^{cr} f 4)	3 (47 9 ^{cr} f 48)	8 (47 5 ^{cr} f 7)	47 (57 87 f 54)
T t l poo l t	5 (3 9 ^{cr} f 47)	58 (4 84 ^{cr} f 4)	5 (5 08 ^{cr} f 48)	9 (5 94 ^{cr} f 7)	7 (4 ^{cr} f 5)



l l l a m d l hth lf f t
ll l m l fth lf lh l t d fth ypt
m l t l th l fth lf l



F 4 Ad m s d d The ll th
t t ll dff t t d tl t p ll
d th t ll f m d

differentiated to such a marked degree and arranged in glandular or acinous formation with such good cell alignment that they appear almost like normal rectal mucous glands. A number of the cells even secrete mucus that is indistinguishable from the mucus secreted by a benign adenoma. As a matter of fact a number of carcinomata of the rectum of low grade malignancy originate in adenomata. Furthermore, contrary to the prevailing opinion, Stunt has shown that the change from a

benign adenoma to a carcinoma take place more often at the periphery than at the base. Mitotic figures may or may not be numerous in the carcinomata showing advanced differentiation but they are usually regular in form. On the other hand carcinomata of the rectum may be so undifferentiated that practically all trace of gland formation are lost. The cell nuclei are usually large, irregularly roundish and deeply staining and as a whole the cells have lost their columnar form.

TABLE A—NO LYMPH NODES REMOVED GRADE OF MALIGNANCY AND RESULTS

	C 1	G d	G 1	G d
N l h ad l	oo s f 9	68 f 9	oo f 8	(6 f 9)
f f m	oo f	8 8 85 f)	oo ^{oo} f)	(oo ^{oo} f
L	5 oo (oo f 8)	5 oo ^{oo} f	
P so l	(oo ^{oo} f)	oo f)	
l l l	f	6 oo f 8)	(5 oo ^{oo} f)	(oo ^{oo} f)
I so l	6 f	oo f)	oo ^{oo} f)	(oo ^{oo} f)
T l l l	8 f f)		oo ^{oo} f)	
T l so l	f	8 oo ^{oo} f 8	5 oo ^{oo} f)	(oo ^{oo} f)

A f ed h h Qu T l H so C p



Fig. 5 Adenocarcinoma graded 3 showing less cell differentiation than Figure 4 with irregular acinar formation



Fig. 6 Adenocarcinoma graded 4 with mucoid formation. Note the undifferentiated state of the cells for the most part and the ill defined acini

Mitotic figures may or may not be numerous but are often irregular (multiple mitosis). When acini or gland formations are found in such carcinoma the cells are not in good alignment and show very little tendency to individual cell differentiation.

In our series of carcinomata we have found a number that show mucoid or colloid secretion. This material may be associated with cells in all degrees of differentiation however on the whole if it is found in large masses the cells associated with it are usually of a columnar type. One often sees acini so distended with this material that a number or all of the cancer cells in them have been destroyed by pressure. When the material is associated with undifferentiated cells it is usually less in amount and is often retained in the cell giving it a signet ring appearance.

GRADES OF MALIGNANCY

The malignancy of carcinoma of the rectum like that of carcinomata in other situations is subject to gradation on the fundamental principle of cell differentiation. In 1915 one of us (Broders) began grading malignant neoplasms on the fundamental principle of cell differentiation and during the following 4 years 1,628 squamous cell epitheliomata were graded strictly from a microscopic viewpoint and absolutely independently of the clinical

histories. In 1915 it was thought best to modify the original basis to some extent. The mitotic figures and the one eyed cells were considered only as undifferentiated cells and it was only in the presence of numerous irregular mitotic figures that there was an inclination to raise the grade.

Recently we have studied 598 cases of carcinoma of the rectum operated on between 1916 and 1915 and graded the malignancy in accordance with Broders' method. From Table I it can be plainly seen that the percentage of cases in which metastasis is present rises in direct proportion to the grade of malignancy and that absence of metastasis increases in inverse proportion to it.

Table II shows the grade of malignancy and its relation to the ultimate result. The percentage of total good results decreases in inverse proportion to the grade of malignancy and the percentage of total bad results increases in direct proportion to it.

Table III shows the relationship of metastasis grade of malignancy and ultimate results. It is evident from the total percentage that the good results decrease in inverse proportion to the grade of malignancy and the bad results increase in direct proportion to it.

Table IV shows the relationship of absence of metastasis grade of malignancy and ultimate results. The percentage of total good



1 7 Ml pth l m f grad d 4 N t th
 m l m cl l t th ht Diff t t th
 f l ly p t

results decrease in inverse proportion to the grade of malignancy and the percentage of total bad result increases in direct proportion to it. While the grade of malignancy has its influence on the good and bad results in the absence of metastasis, this influence is not as marked as when metastasis is present. It can also be noted that in case of carcinoma graded 3 or 4 without demonstrable metastasis the result is not much better than when metastasis accompanies a carcinoma graded 1.

In Table V the grade of malignancy and the result are compared in a series of cases in

which the nature of the operation precluded the removal of lymph nodes.

Table VI shows the relationship of grade of malignancy, ultimate result and duration of life since operation. It can be seen that the grade of malignancy plays practically no part in the average duration of life of those who are living and it plays practically no part in the duration of life of those who died after a good result, but it plays a part in the average duration of life in those who died from the carcinoma, since the average duration decreases as the grade of malignancy increases (Figs. 1 to 7).

CONCLUSIONS

1. Extrinsic influences are in the main modifying in type, age being one which emphatically prejudices successful prognosis.

Duration of the growth is important but its exact determination is difficult, change in bowel habit and obstructive phenomena being the most dependable signs which call attention to the presence of a growth.

3. Fixation influences operability and in consequence operative mortality and successful outcome. Fixation in many instances is the result of inflammatory changes rather than direct extension of malignancy and in consequence radical maneuvers in selected cases give unexpectedly successful results, although this is the exception rather than the rule. Occasionally drainage operations permit a recession of inflammatory processes and sub

TABLE VI.—GRADE OF MALIGNANCY, ULTIMATE RESULT AND DURATION OF LIFE

	1	2	3	4
1 1	5			5
1 f m				5
L	5			8
L h	5 3	∞	3	7
P	∞		37 3 21	∞ 3
A h	3		∞ 3	5
A h				5
1 1		5		5
L h	8	3		6 3 3
P	5	8 3		∞
A h	7 7 5 7 5	3) m	8 ed) m	35 (5 m ed)
A h	7 7 5 7 5	66 7 5	6 00 3 05 6 3	7 5 y

sequent resection after immobility has been considered sufficient to rule out resection at the primary exploration

4 Site of the growth influences outcome because of pathological type and early detection epitheliomatous of the anal canal being early recognizable and satisfactorily removed by local operation while the type of neoplasm found higher in the rectum is practically always adenocarcinomatous

5 The grade of malignancy has a direct bearing on the percentage of metastasis and absence of metastasis since the percentage of cases showing metastasis increases in proportion to the grade and the percentage of cases without metastasis increases in inverse proportion to it

6 The influence of the grade of malignancy on the ultimate result is indicated by the fact that the total of good results decreases in inverse proportion to the grade while the total of poor results increases in proportion to it

7 From a comparison of the influence of metastasis and that of the grade of malignancy it is obvious that the grade of malignancy is the dominant factor since the total of good results decreases in inverse proportion to the grade and the total of poor results increases in proportion to the grade

8 When the influence of the absence of metastasis and of the grade of malignancy on the ultimate result are considered together the influence of the grade is still evident but

not to such a marked degree as when it is considered with metastasis

9 If the percentage of metastasis increases as the grade rises and the influence of the grade of malignancy on the ultimate result has been established beyond doubt it is reasonable to assume that the total of the good results in the presence of metastasis will not be as high as and poor results higher than when metastasis is absent furthermore the total of good results when metastasis is absent should be higher and the total of poor results lower than when metastasis is present Actually the total of the good results when metastasis was present was 20.68 per cent and the total poor results was 79.31 per cent When metastasis was absent the total good result was 57.87 per cent and the total of the poor result was 42.12 per cent

10 It will also be noted that almost as good a result is obtained in the case of carcinoma of the rectum graded 1 with metastasis as in the case of carcinoma graded 3 and 4 without metastasis Furthermore there has not been a good result in this series when malignancy was graded 4 and metastasis was present

11 The influence of the grade of malignancy on the duration of life after operation in cases in which death occurred from the carcinoma is shown by the fact that the average duration decreased as the grade increased

HYDATID DISEASE OF THE KIDNEY

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HYDATID disease is distributed throughout the world in those countries that have become famous for wool growing Australia New Zealand Argentine Iceland Southern Europe and Northern Africa

In Australia the name *tania echinococcus* has become restricted to that for the parasite itself. When it attacks human beings it assumes the bladder worm stage and the condition produced is always known as hydatid disease.

Sheep dogs and men are the three factors concerned in the development of the disease. It takes on an average of 15 to 20 years from the time of infestation before the patient seeks surgical relief so slowly and insidiously does hydatid disease progress. If the encouragement of wool growing in the United States of America and Canada continues we feel sure that the next generation of surgeons in these two great countries will have more opportunities of studying the manifestations of hydatid disease than their predecessors had.

Public health measures in Iceland and Australia have brought about a definite reduction in the disease as manifested in man. Sheep farmers know the danger of feeding their dogs on the uncooked liver of infested sheep. This one step arrests the disease at its source.

Of 140 cases of hydatid disease admitted into the Royal Prince Alfred Hospital during the past 42 years in 8 or 10 per cent the disease affected the kidney. It is not a common disease. During the past 15 years 16 cases of renal hydatid have come under our observation. A summary of the histories is appended. Of the 16 were male 5 were female 8 were in the right kidney and 8 in left. The average age when the patients were seen was 40 years. The youngest patient was 9 years old the oldest 67.

The hydatid embryo may reach the kidney at the primary infection of the host even if the infection consists of only a single embryo. If the infestation consists of many embryos then the kidney will share its fortune with other organs.

A secondary infestation of the kidney may occur from the rupture of a hydatid cyst into some part of the blood stream. If the patient survives this disaster the kidney along with other organs may be the seat of many hydatid cysts. Clinically there may be so many tumor present that the diagnosis of secondary malignant disease is made. This type of multiple infection of the kidney is usually discovered postmortem and has never in our surgical service come within the scope of operative surgery.

In this series of cases we include only those hydatid that arise within the kidney substance. Some authors (10) include infestation by implantation on the juxta renal peritoneum. In the surgical service of the Royal Prince Alfred Hospital Sydney we have not seen a hydatid cyst which has invaded the kidney in this way. Many have been found in contact with the kidney but never truly invading it. Expansion of a hydatid occurs along the line of least resistance which is under the circumstances toward the peritoneal cavity and away from the kidney.

If a hydatid were anchored by firm peritoneal adhesions close to the kidney it would be theoretically possible for it to invade the kidney. We have yet to see this happen.

Hydatid within the peritoneal cavity should be classified as abdominal or peritoneal. They arise from traumatic or spontaneous rupture of a hydatid of the liver or spleen into the peritoneal cavity. The kidney peritoneal pouches as well as other pouches are involved in a general infection of the peritoneal cavity. This type of infection also follows the



FIG. 1. Hydatid of the lower pole of the left kidney Anterior aspect

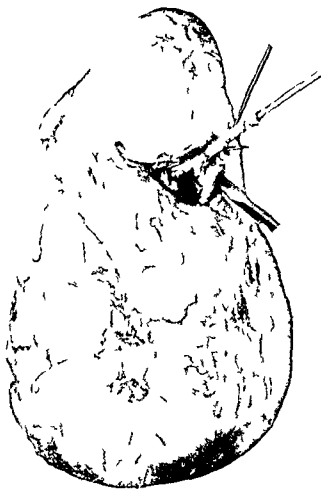


FIG. 2. Same kidney as that shown in Figure 1 from medial aspect

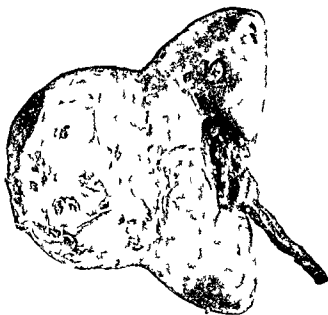


FIG. 3. Cystic malignant growth of right kidney closely resembling hydatid of the kidney



FIG. 4. Small hydatid of the left kidney containing two daughter cysts

HYDATID DI

B CORDON CL M C M B CH M
H g L IK K LEE BROWN
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Public health measures in Australia have brought about a reduction in the disease as manifested. Sheep farmers know the danger of their dogs on the uncooked liver of sheep. This one step arrests the source.

Of 1460 cases of hydatid disease reported into the Royal Prince Alfred Hospital the past 4 years in 1908 or 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 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4087 4088 4089 4090 4091 4092 4093 4094 4095 4096 4097 4098 4099 4100 4101 4102 4103 4104 4105 4106 4107 4108 4109 4110 4111 4112 4113 4114 4115 4116 4117 4118 4119 4120 4121 4122 4123 4124 4125 4126 4127 4128 4129 4130 4131 4132 4133 4134 4135 4136 4137 4138 4139 4140 4141 4142 4143 4144 4145 4146 4147 4148 4149 4150 4151 4152 4153 4154 4155 4156 4157 4158 4159 4160 4161 4162 4163 4164 4165 4166 4167 4168 4169 4170 4171 4172 4173 4174 4175 4176 4177 4178 4179 4180 4181 4182 4183 4184 4185 4186 4187 4188 4189 4190 4191 4192 4193 4194 4195 4196 4197 4198 4199 4200 4201 4202 4203 4204 4205 4206 4207 4208 4209 4210 4211 4212 4213 4214 4215 4216 4217 4218 4219 4220 4221 4222 4223 4224 4225 4226 4227 4228 4229 4230 4231 4232 4233 4234 4235 4236 4237 4238 4239 4240 4241 4242 4243 4244 4245 4246 4247 4248 4249 4250 4251 4252 4253 4254 4255 4256 4257 4258 4259 4260 4261 4262 4263 4264 4265 426

When once the hydatid has burst into the urinary tract further increase in size of the parent cyst ceases. Any increase in tension due to the natural growth of the cyst is relieved by the safety valve action of the opening into the calyx. In one of our series no alteration in size of the tumor had taken place in 10 years although the patient stated that before one of his attacks of hematuria and renal colic he thought he could feel the lump more easily.

In hydatids of the upper pole when once the liver or spleen has been invaded the safety valve action does not control further invasion of the other two organs.

Calcified hydatids of the closed variety as a rule produce no symptoms and they are discovered only in a routine urological examination for some intercurrent disease. Under trauma they may lead to severe hematuria but seldom if ever sufficient to justify surgical interference. A fully calcified hydatid is a dead hydatid and unless causing symptoms should be left alone.

A calcified hydatid of the open type may cause a symptom of renal colic from the passage of calcified debris down the ureter. Surgery is then indicated. Case 15 was of this type.

Cystoscopic examination yields the evidence of a turbid efflux from the ureter during an attack of hematuria. The mucous membrane of the bladder is seldom involved even in infected open hydatid of the kidney. In one of the series (Case 6) an acute cystitis was found but we were not convinced that there was any relationship between the calcified hydatid of the kidney and the cystitis.

In open renal hydatids routine microscopic examination of the bladder and kidney unnes may reveal besides red blood cells pus cells and hydatid hooklets. What is just as characteristic and less difficult to find is fragments of laminated chitinous hydatid membrane. Nothing else resembles it.

Functional test by phenolsulphonephthalein. Unless gross destruction of the kidney has been brought about we have not found any difference in function between the two kidneys. In one case where the right kidney was destroyed there was a complete absence of function on that side.

Pyelography is of great value when a positive deformity is shown but the absence of deformity does not exclude the presence of hydatid. Kretschmer (5) published a pyelogram of an upper pole hydatid which showed deformity of the upper calyces. We show a pyelogram of a lower pole hydatid which illustrates a filling defect of one of the lower calyces. In the future we expect to be able to demonstrate some deformity in the pyelogram of all open hydatids of the kidney.

In a closed hydatid of the lower pole of the kidney no deformity of any calyx could be demonstrated. This is true of solitary cysts of the kidney which like closed hydatid when once they have reached the capsule expand like a hernia in a radial direction away from the center of the kidney. No pressure is exerted on the calyces or pelvis. If the closed hydatid is situated in the center of the kidney a deformity would be expected. We have yet to demonstrate this.

We had the opportunity of taking a pyelogram of a case in which the whole kidney had been destroyed by the hydatid. Nothing but the blind upper end of the ureter could be demonstrated opposite the second lumbar transverse process.

On pyelographic evidence there should be little difficulty in differentiating a hydatid from a solid tumor; the latter causes more spider-like deformity than a hydatid of the same size. Pyelography cannot differentiate between a solitary cyst of the kidney and a closed hydatid.

LABORATORY TESTS

Blood count. Much work has been done in Australia during the past 20 years to develop tests that could be relied on in the diagnosis of hydatid disease.

In common with other parasitic worms that infest the human race the echinococcus alters the relative percentage of the white cells of the blood. Welsh and Barling (8) (*Australian Medical Gazette* August 1906, 383) found that the eosinophile count was increased in 50 per cent of the cases observed. This is a test that we use today and if positive it is of considerable value. One of our cases showed an increase from the normal 2 per cent to 10 per cent.

Precipitin reaction Welch Chapman and Storer (9) (*Australian Medical Gazette* December 1905 653 and *Lancet* April 1909 1105) showed that the precipitin was derived not from the antigen but wholly or almost wholly from the antiserum.

Dew and Williams found that the precipitin test and the complement deviation test run a parallel course but the former is not so delicate nor is it quantitative in the same way. It proved positive in 50 per cent of the patients examined ().

Complement fixation test of Chalmers Turley (4) has shown that the complement fixation test of Chalmers is positive in 84.3 per cent (84 per cent) when tried in a series of 53 cases.

Dew and Williams () confirmed the findings and showed that if this test were combined with the *intradermal test of Casanovi* a positive finding should be obtained in 90 per cent of the cases of hydatid disease.

Intradermal test of Casanovi Dew Kellaway and Williams () using the intradermal test of Casanovi alone found it better than the complement fixation test. It gave positive findings in 90 per cent of the uncomplicated cases.

In clinical work we have found as have others that the reliability of the test depends upon the freshness of the antigen. It fresh hydatid fluid from the cysts in the liver of a sheep used reliance can be put on the result. The addition of phenol to make a solution of 0.5 per cent enables the antigen to be kept for some months if placed in an ice chest. If the antigen is old pseudo-positive results may appear in patients who do not suffer from hydatid disease. We have found that the error may be 10 per cent. In other words if 10 patients who are in a general surgical ward are tested with antigen that is 2 months old

may give a positive result. When these are tested with fresh antigen they give a negative result. This experiment requires repetition but it is sufficient to demonstrate the weakness of the test. In spite of this we are coming to rely more and more upon the tests of Chalmers and Casanovi as an aid in the diagnosis of hydatid. When a reliable antigen is obtained that will keep for at least 6 months it will be of service in all countries.

DIAGNOSIS

In a review of our series of cases it is interesting to note the improvement in the percentage of pre-operative diagnosis since full routine urological investigations have been made. Previous to this period there were 8 cases 3 of which were correctly diagnosed. Since full investigations have been made the rule 7 of 8 cases were correctly diagnosed before operation. The eighth case was strongly suspected as being of hydatid nature but the complement deviation test was inconclusive and the Wassermann test was strongly positive. For these reasons a malignant or syphilitic tumor of the kidney was given preference.

It is only fair to mention that in the first 8 cases 6 were closed hydatids and 2 were open while in the last 8 only 3 were closed and 5 were open. As has been pointed out the pre-operative diagnosis of a closed hydatid is much more difficult than that of an open one. All open hydatids of the kidney should be correctly diagnosed. In 1 of the first 8 cases the hydatid was discovered post-mortem the patient having died of acute bronchopneumonia and cholelithiasis.

In palpating kidney swellings we have adopted for more than 10 years a method of examination in which we apply with the fingers of one hand strong pressure from behind in the costo-vertebral angle with the object of lifting the kidney out of its paravertebral groove while light pressure is applied in front with the other hand. This method preserves all the delicacy of light tactile sensation and reveals enlargements of the kidney that otherwise would be missed. Probably many others use the same means. Spurr describes a method of lateral percussion and palpation to determine the presence of kidney swelling. This method embodies the same principle of lifting the kidney out of its groove (6).

In our experience a full clinical history and urological investigation has so far been of greater service than laboratory tests but the tests are becoming increasingly important in the chain of evidence. In closed hydatids they are of more use than in the open type. In the open type a positive diagnosis should

be arrived at without their aid. A microscopic examination during an attack of renal colic and hematuria and even between attacks should reveal the presence of hooklets or what is more common but equally characteristic a fragment of laminated chitinous cyst wall.

If when the tumor is palpated the characteristic hydatid thrill can be elicited it is a pathognomonic sign. Unfortunately it is rare and difficult to find in any part of the body and especially so in the kidney. In 1 of our 16 cases a hydatid of the lower pole in which the tumor came well down toward the iliac fossa we could elicit the thrill. We were able to secure the thrill by pressing on the medial side of the tumor with one hand and percussing on the flank with the middle finger of the other hand. The fluid and semi solid contents of the cyst gave the sensation of quivering under the percussion finger. If a cylindrical tin container with a thin top and bottom is filled with boiled starch of the consistence of *blanc mange* the hydatid thrill can be demonstrated by tapping the lid. Another material that can be used is *linimentum tercinth* (*British Pharmacopœia*).

TREATMENT

The recognition of the fact that there are two types of hydatid of the kidney—the open and the closed—and that each type requires different treatment simplifies the surgery of this disease. With the opportunities at our disposal we are now able to give our views upon the indications for and choice of operation with some measure of clearness.

We are satisfied that all living hydatids should be treated surgically until such time as a drug is discovered that will kill the parasite without killing the host. Further emetic has transformed bilharziasis from the domain of surgery to that of medicine. Let us hope that some such drug may be discovered for hydatid disease.

If untreated the disease takes a long time to kill a patient but kill him it almost certainly will. We have evidence that it can cause sudden death from embolism or anaphylaxis that it can produce intestinal obstruction that it can extend to other organs and that

during its progress it can inflict much needless suffering on the patient.

In surgical literature nephrectomy is recommended as the operation in all cases of hydatid of the kidney. We would agree with this recommendation if it were restricted to all cases of open hydatids of the kidney. If the kidney pelvis is in communication with the infected or uninfected cyst nephrectomy is indicated if it can be performed. It is surgically unsound to leave a cavity in communication with the urinary tract which if not infected previous to operation is very likely to be afterward.

In 2 open hydatids in our series nephrectomy had to be abandoned on account of severe hemorrhage when the adhesions to the liver were separated in 1 case and to the spleen in the other case. Marsupialization with drainage was carried out as the next best step. One case (Case 10) lived for 10 years and died at the age of 69 from liver pleural and pulmonary extensions of the original kidney hydatid. The other (Case 9) died suddenly 2 years afterward from hydatid embolism or anaphylaxis. The urine of both these patients was infected up to the time of death.

Closed hydatid of the kidney differs in no essential from a hydatid of the liver. Marsupialization or Lindeman's operation in some form has proved for nearly 50 years a safe sound procedure for closed liver hydatids. In our work it has proved applicable to kidney hydatids. This operation was carried out in 5 cases of closed hydatids in our series with uniformly good results both immediate and remote. A closed hydatid of the upper or lower polar region of the kidney never destroys the whole of the organ. Sufficient cortical tissue remains to justify a conservative operation.

Today improved serological tests render the task of diagnosis of closed hydatids of the kidney an easier one but if a preoperative diagnosis cannot be arrived at it is not advisable to do anything but a nephrectomy because of the risk of mistaking a malignant cyst of the kidney for a hydatid. In one case a sheep farmer had a spherical renal tumor 10 centimeters in diameter. A Ghedini and Casoni test gave a negative result for hydatid disease.

evacuated through an incision made at the site of the trochar puncture. An instrument shaped like a long handled teaspoon or table spoon is useful in removing the numerous daughter cysts. It sometimes takes half an hour to three quarters of an hour or longer to clean out a large cyst thoroughly. A wide bore suction apparatus is also of help in cleaning the recesses. When this cleansing is accomplished we again treat the collapsed cyst by swabbing it out with alcohol. Before the cyst is incised or after it is emptied the adventitious cyst wall is stitched to the deep aspect of the abdominal muscles with chromicized catgut that will last for 14 days at least. The incision in the cyst is left open. The abdominal wound is then closed in layers with a small rubber dam drainage down to but not into the cyst. This drain is removed in 3 or 4 days if all goes well. Sometimes the cyst drains freely for a longer period when this occurs we allow the rubber dam to remain longer. We have given up the use of large calibered rubber tube drains as they lead to postoperative infection. If the cyst is large and communicates with the liver or spleen we make an exception and use large tubes. Under such circumstances daughter cysts may be discharged through the tube for many weeks as it is impossible to evacuate the irregular cavity thoroughly if the cyst proves to be of the branching loculated type.

The safest method of all to prevent the escape of cyst contents into the perirenal tissue is a two stage operation. At the first step the cyst is exposed by the usual method and stitched to the abdominal wall. The wound through the abdominal muscles is left open and packed with gauze. Ten to 14 days later when adhesions have shut off the surrounding areas the cyst is evacuated as described.

The two stage operation has been successfully used in hydatid of the brain and certain deeply situated abdominal hydatids. Up to the present we have not seen the occasion to use it in hydatid of the kidney.

Formalin in 10 per cent solution is used by some Australian surgeons in the same way as we use alcohol to devitalize the parasite. It is claimed to be quite satisfactory.

The Bond Delbet Posadas operation in which the cyst is opened evacuated and allowed to drop back without being stitched to the abdominal wall we have not done. While many brilliant results by primary healing have followed this method there have been in Australia sufficient postoperative deaths from leakage and infection to restrain us from attempting it. With all the precautions that are taken it is difficult to be sure that every scolex has been destroyed by the alcohol or formalin. If the cyst is dropped back without being secured to the abdominal wall any living scolex will lead to a secondary implantation in the deep perirenal tissues if it is stitched to the abdominal wall implantation can take place only in the superficial scar tissue. This complication arose in one of our series (Case 10). We had no difficulty in excising completely the whole cyst with some surrounding scar tissue.

The operation of nephrectomy through the usual oblique lumbar incision presents no more difficulties in hydatid disease than it does in any other disease of the kidney.

The opportunities of studying the clinical aspects of hydatid disease that have fallen to the lot of the surgical staff of the Royal Prince Alfred Hospital particularly during the past 50 years are unlikely to occur again in the same space of time.

It is with the object of placing one phase of this disease before our colleagues in other countries that this communication has been given. At the same time we wish it clearly understood that we are giving our own personal views and do not imply that they necessarily represent the views of other members of the surgical staff.

CASE 1. C. S. female age 1 years. Family history good no previous illnesses. For the past 2 years patient has had dragging bearing down pain on the right side of the abdomen attributed to heavy work. The pain has been worse during the last 10 months has been constant and worse after exertion. It is confined to the right side of the abdomen and to the right loin. Attacks of vomiting have occurred 5 and 3 weeks ago. During these attacks there has been marked increase of pain in the right side of abdomen and right loin. During the last few months there has been increased frequency of micturition accompanied by occasional scalding three to four times during the day twice

at night There has been hematuria on 4 occasions
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 tim tel mi el with the urine Examination of the
 uie h ed ct on ac l specific gra vity 1025
 f nt cl ul of albumi a fe pu cell A la ge
 ru lei tum xten lei from the right loin to
 lm t the midline in fr nt t was full percus
 i a l movel on respiration Operati con
 t t f l mb eph stomy thr ough high
 th te t f th cv t c nsi ting f ume able
 l htr r t a l m pu cell vere e acuate
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(C) R C m le age 43 ar Family
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l l h l p d a l f u l m p t y
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man No definite tumor of the left k dne could be
 demonstrated latholo ical examination f the
 urine sho el it t co ta n pus an l blood No look
 lets seen Blood examination showed the precipitin
 test fo h y d a t i l f a i t l y p o s i t i v e A left lumbar
 nephrectomy as performed The lo er pole of the
 k d n e y w a s o c c u p i e d b y a h y l a t i d c y s t a b o u t 3
 i n c h e i n l r i m e t e r f i l l e d w i t h l a u g h t e r c y s t s
 Patient was di charge l fr m the ho p i t a l 5 v e e k s
 a f t e r the p e t i n The w o u n d s a s h e a l e d

CASE 4 M J l fem le age 33 year
 Lived all her life in the country T o v e e k s a g o
 patient had a rigor f l l o e d b y v o m i t i n g l r h e a
 and jaundice The e s y m p t o m s h a v e p e r s i s t e d e v e r
 i n c e F r t h l a s t i m n t h s s h e h a n o t i c e d a h a r d
 w e l l i n g i n the l t h y p c h o l u m w i t h a d r a g g i n g
 b i g l o p a h i c h g e t s v o r s e o e x e r c i s e
 S i n c e the o n e t of i l l n e s t h e r e h a s b e e n a n i n c r e a
 e f f e q u e s y m p t o m i a c c o m p a n i e d b y s c a l l i n g
 U n e h a b e e n d a r k c l o r O n e a m i n a t i o n
 e f u l p r a t e n t j a u n d i c e d i t h a h a r d r o u n d e d
 t u m o r s i t u a t e d i n the l e f t h y p c h o n d r u m m o v a b l e
 o b m u l x a m i n a t i o n C y t o s c p y s h o e d the
 e f f l f r o m the r i g h t u t e r c l e a r t h a t f u s a n d c a s t s
 i n b o t h p e c i m e n m o e m a k e l o n the l f t s i d e
 B l o e x a m a t o n h o v e d 1 p e r c e n t e o s i n p h l a
 N o o p e r a t i o n a s p e r f r m e l l a t e n t l e l 2 v e e k s
 a f t e d m s n l t m o t e m e a m i n a t i o n s h e d
 b o n c h o p n e u m o n i a c h o l e t h s s a n d i n b o t h k d
 n e y s a n a c u t n e p h t i The l o w e r p o l e f the l e f t
 k l e y w a s o c c u p i e d b y a s p h r i c l h y l a t i d c y s t
 c o n t a i n i n g n u m o u s d u g h t e c y s t s b u t n o c m
 m u c t o v a f u n l i t h the u r i n a r y p e l v i s

CASE 5 V M O fem le ge 10 years I a
 t i e n t h a s a l l v i d e d i n the c i t y W h e n h e a s
 7 v e a of a g e s h e h a l a n o p e r a t i o n f o r t u m o r of the
 l i v e a l t b e h y d t d O n e y e a f e r e a d m i i n
 s h h d a c u t e r i g h t r e n a l c o l i c a n l i m o n t h l a t e r
 s l e n o t i c e l a m o b l e l u m p i n the r i g h t h y p o c h o n
 d r i m N t h i n g w a s l o e o n a c c o u n t of the f a c t
 t h t s h e s 4 m o n t h s p r e g n a n t S e e the b t h of
 the c h i l d the p a i n h a s b c o m e m o e e r e a d of
 a d u l l d r a g g g c h a r a c t e and the l u m p h a s i n
 c r e e d n s i z e E x a m i n a t i o n s h o e l t h e r a l a r g e
 u n d e r t u m o r i n the r i g h t h y p o c h l u m l i c h
 a w e l l f l t b i m a n u a l l y a n l m e l o r e s p a t r n
 The u m e c o t n e d n o a l b u m n u g r o r p u
 B l o e x a m t i n 7 p e r c e n t e n p h i l a T h r o u g h
 a g h t l u m b a r n e p h r o t o m y a h y l a t i d c y s t i t h
 n u m e r o u s l a u g h t e r c y s t s a s r e m o v e d The e l g e f
 the a d e n t i t i o u s c y s t a s s e e d to the a b l o m i n l
 a l l C v a l e c e v a s s l The p a t i e n t d i
 c h r g l 8 v e k s t e r a r l t h s i n u t i l l a n g

CASE 6 W H B mal age 67 years I a
 t e n t h a d a n a t t a c k of h a m a t u r i a 6 e e k s a g o
 of u d l e n o n s e t a c c o m p a n i e d b y s c a l l g a n d p a n
 a l o n g the p e n i s T h i s c o n t i n u e l m o r e r l e s s u n t l
 10 d a y s a g o h e n the s y m p t o m t m o t c o m p l e t
 s u b s i d e d N t v e a m i n a t i o n s h e l a t p a l c a l
 c i e d h y d a t i n the r i g h t k i l v C y s t o c o p i c
 e x a m t o s h d a m r k e d c y t t i t i l l p r e s e n t

Examination of the urine showed pus cells red blood cells and motile organisms. The attack of cystitis completely subsided after 2 weeks rest. As this attack of cystitis had no apparent relation to the calcified hydatid in the right kidney, no operation was advised.

CASE 7 G C male age 58 years Patient has lived at times in the sheep country since childhood. He is said to have had hydatid disease of the liver 28 years ago and 9 years ago. Three days ago he had a sudden acute pain in the left iliac region which was colicky in character. Urine at this time was as dark as treacle stools were light in color. He vomited a month ago. He had some slight pain on micturition with increased frequency. Examination showed patient very jaundiced with tenderness in the right hypochondrium and the liver 4 inches below the costal margin. On the left side of the abdomen there was a tumor about 3 inches in diameter movable on respiration with its lower margin at the level of the iliac crest. A muscle splitting incision was made at the level of the iliac crest and a retroperitoneal tumor was found arising from the lower pole of the kidney. This was opened and hydatid and daughter cysts were removed. The adventitious cyst was sewed to the abdominal wall and a drainage tube inserted. Patient was then turned on his left side and a trans thoracic hepatic omy performed in the midaxillary line at the level of the tenth rib. The hydatid cyst was marsupialized after removal of its contents. Convalescence was slow. Patient was discharged 5 weeks afterward. Kidney wound had closed but the hepatic wound was still discharging.

CASE 8 W McD male age 9 years Patient had had no previous illnesses. For the past 6 months the mother has noticed that there has been a swelling in the right side of the abdomen which has increased in size from the time it was first noticed. The child has never complained of any pain and has been perfectly well in health. The urine has never shown any alteration from the normal. Examination showed a rounded swelling 3 inches in diameter in the right hypochondrium tense full on percussion which moved on respiration. A muscle splitting incision was made over the most prominent part of the swelling the content of the cyst were aspirated then it was opened and the daughter cysts and the endocyst removed. The margin of the adventitious cyst was then stitched to the peritoneum and the abdominal wall and a rubber tube drain inserted. Five weeks afterward patient was discharged from the hospital with a small sinus still discharging.

CASE 9 S A W male age 35 years Patient lived in sheep country in his childhood and in the city during adult life. He has had no previous illnesses. Nine months ago he had a sudden severe colic like pain in the left lumbar region. He was ill for 3 weeks. During this time he vomited once or twice a day. The urine was blood stained at intervals during this initial attack. He was well for 3 months and a similar attack of left sided pain

occurred but there was no vomiting. Patient has had a constant dull dragging pain ever since in the left loin. Five weeks ago there was a slight recurrence of the hematuria no increase of frequency. At intervals during the last 5 weeks he has noticed that the urine has contained a substance like jelly fish. The lower pole of the left kidney is palpable but not definitely enlarged.

Microscopical urine examination showed collapsed daughter cysts present microscopic examination showed laminated membrane hooklets pus and blood.

The patient left the hospital at his own request and returned a year later. He remained well until 4 months ago when he noticed discomfort after eating accompanied by flatulence and pain in the left hypochondrium and left loin no vomiting. During the last 8 weeks he has passed grape skins in the urine. Examination showed that the lower pole of the left kidney is still palpable but not more clearly than it was 12 months ago. Urine contained pus cells red blood cells and hooklets. Blood examination showed 6 per cent eosinophilia. Urine from right kidney decreased with cystoscope contained no abnormal elements. No urine could be obtained from the left kidney although there was a turbid efflux from this ureter before the passage of the catheter. The left kidney was exposed and a hydatid cyst was found involving the upper pole of the kidney extending nearly to the vertebral column and upward to the diaphragm. Anteriorly it was adherent to the spleen and when an attempt was made to separate these adhesions a sharp hemorrhage occurred. For this reason the cyst was aspirated and its contents evacuated. The cyst wall was then marsupialized. The contents consisted of daughter cysts and endocyst intermingled with purulent fluid. Two years after operation he took a fit in a railway train and died within 10 minutes. No post mortem examination was made.

CASE 10 S R female age 59 years married 25 years 6 children youngest age 15 Patient has lived all her life in the country. Her husband is a sheep farmer. Both her parents lived over 80 years. Menstruation ceased at 46. No previous illnesses. Eight months ago patient had an attack of renal colic and pain extended from the right loin to the vulva. Urine was accompanied by slight hematuria. The urine was dark in color and the patient noticed in it bladder things about the size of a green pea. There was nothing more until 3 weeks ago when she noticed a number of similar things in the urine. Examination showed in the right hypochondrium a rounded tumor palpable on deep inspiration which slipped back out of reach on expiration. An X-ray examination of the right kidney showed a large shadow suggestive of kidney tumor. Cystoscopic examination showed flaps of mucus pus floating in the bladder. The mucous membrane showed generalized mild cystitis. The right ureteral orifice was oedematous and swollen the left was normal. A catheter was passed to the pelvis of each kidney.

97 per cent ethyl alcohol and was explored with the finger. No communication with the pelvis could be found. We completed the operation by allowing the wall of the cyst to collapse and the opening in the cyst was closed with a continuous plain catgut suture. The cyst itself was then sewed to the margin of the wound so as to anchor it. The muscles and remaining tissues were closed in layers with a rubber tissue drain at the lower angle of the wound leading down on to the closed incision in the cyst. The drain was removed in 3 days and the wound was completely healed by first intention in 2 weeks. Patient was discharged from the hospital 2 weeks after operation. He returned to duty 1 month after leaving the hospital and worked for 9 months continuously. He had some pain at the site of the wound after a hard day's work. Ten months after operation the wound was soundly healed and he looked in perfect health. Urine showed no albumin, no sugar, microscopically no pus, no red blood cells.

CASE 12 J. R. male, age 50 years, married. Water works engineer. Father died at 41 of Bright's disease. Mother died at 48 from an aneurism. Patient lived in the country as a child. Was at sea for 10 years. Had spirochæte infection at the age of 30. Has been ailing for the last 3 months with a dull dragging feeling in the left hypochondrium aggravated by driving in a motor car. Seven weeks ago after a long drive he felt a lump in the left side of the abdomen for the first time. He has noticed that he gets some shortness of breath on going up stairs, no swelling of the feet. No loss of weight. Examination showed a cystic swelling in the left hypochondrium extending into the left loin. The lower margin of the swelling is on the level of the iliac crest and extends to within $2\frac{1}{2}$ inches of the middle line. Urine showed no albumin, no sugar, microscopically no pus, 1 red blood cell to a field, $1/6$ objective. Cystoscopic examination showed early trabeculation of the bladder walls, no cystitis. There is early intravesical enlargement of the prostate. Differential phthalein test returned from the right kidney 6 per cent in half an hour from the left 5 per cent in the same time. The left kidney specimen showed an occasional pus cell and red blood cells. Ithalein test gave 30 per cent in the first hour and 10 per cent in the second, making a total of 40 per cent. Pyelogram was not taken on account of breakdown of the X-ray plant. An X-ray taken previously showed a rounded tumor in the region of the left kidney with a protuberance from the general outline of the tumor at its lower pole. This protuberance reaches the level of the iliac crest. The lower pole of the main tumor shows an increased density suggestive of early calcification. Wassermann test triple positive. Blood count showed neutrophils 73 per cent, lymphocytes 19 per cent, eosinophils 5 per cent, transitional and large mononuclear 3 per cent, basophils 1 per cent. Complement fixation test for hydatid gave doubtful outcome. Pathological report in view of the positive Wassermann test, the absence of eosinophilia and the presence of leucocy-

tosis a hydatid infection is not suggested. A left nephrectomy was done through an oblique lumbar incision. The upper pole appeared to be normal, the lower half was occupied by a cyst more or less spherical in outline $4\frac{1}{2}$ inches in diameter. The cyst was fixed in formalin solution before being opened. It was sectioned 1 month later and proved to be a hydatid cyst. There was no evidence of suppuration, but it was tightly packed with daughter cysts. The wound healed by first intention and the patient left the hospital 19 days after the operation. He has been quite well and at work ever since.

CASE 13 W. D. age 30 years, male, married, builder. Patient has lived in the country all his life but has not raised sheep for 20 years. He has had attacks of hæmaturia for the past 13 years. The first attack was colic like in character and the pain extended from the right loin down to the right groin. These attacks at first were at intervals of about 6 months but lately have been more frequent. As far back as 12 years ago he passed a little bloody thing in the urine following one of these attacks of pain and hæmaturia. At times he is able to trace the track of the pain down from the kidney toward the bladder region and when it reaches there he gets relief. The passage of the cysts through the urethra causes no discomfort merely a temporary stoppage in the stream. As he is a house builder his estimate of the size of the cysts that he has passed is probably correct. He states that he has passed cysts varying in size from $\frac{1}{8}$ to $\frac{3}{4}$ of an inch and when passed into a vessel they appear spherical in outline although they emerge from the meatus in an elliptical form. The hæmaturia has been more marked of late accompanied by clots. He estimates that in the last attack which occurred 14 days before admission he lost about half a pint of blood. No cysts have been passed during the past 3 months. Phthalein test returned 45 per cent first hour, 5 per cent second hour, total 50 per cent. Cystoscopic examination of bladder wall showed a very slight injection of the mucous membrane. Both ureters were catheterized to the pelvis without obstruction. Specimen from the right side showed a trace of blood (traumatic) that from the left was slightly turbid. A plain X-ray picture of the upper tract showed an increase in the left kidney shadow. A pyelogram showed a filling defect involving the lower calyces. When the patient was examined 10 years previously by a surgeon his attention was drawn to a lump in the left side of the abdomen which he states has not increased in size although he thinks that before an attack of hæmaturia comes on it gets a little larger. There has been no increase of frequency of micturition, no pain even when passing cysts. Urine shows faintly cloudy, albumin, left kidney specimen contains pus, red cells and fragments of laminated membrane. Examination shows the lower pole of the left kidney definitely enlarged when it is felt manually. Differential blood examination shows neutrophils 61 per cent, eosinophils 5 per cent, lymphocytes 30 per cent, large mononuclears 4 per

round the middle calyx. Patient made an uninterrupted recovery and since the operation has gained five stone (70 pounds).

SUMMARY

1 Hydatid is a disease of wool growing countries. The United States and Canada are gradually coming under this classification.

2 As it takes 15 to 20 years from the time of infestation for hydatid disease to manifest itself it will be the rising generation of surgeons of North America who will be interested.

3 There are two types of hydatid of the kidney: (a) the open type which communicates with the renal pelvis and (b) the closed type which has no communication with the renal pelvis.

4 The diagnosis of the open type is comparatively easy if a full clinical and urological examination is made but the diagnosis of the closed type is difficult and requires the aid of the intradermal test of Casoni or the complement deviation test of Ghedini.

5 Nephrectomy is the operation of choice in open hydatids. Marsupialization or ne-

phrostomy after devitalizing the contents of the cyst with alcohol or formalin is the safest and best operation for closed hydatids.

6 Subtotal nephrectomy may prove a useful operation when the function of the other kidney is poor.

NOTE.—Those interested in the subject of hydatid disease will find full and exhaustive reference to the literature in the monograph *Hydatid Disease* by Harold Dew, Australian Medical Publishing Co. 1927.

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OSTEITIS FIBROSA CYSTICA OF THE SPINE

By ALFRED W. ADSON, M.D., IACSR, T. MIN. T.

Sec. 10, N. 1, S. 5, E. 3, M. 1, L.

My reason for reporting the two following case of osteitis fibrosa cystica of the spine is to emphasize the fact that the disease occurs in other than the long bones of the body that trauma and infection are suggestive etiologic factors and that roentgenograms are of diagnostic value in differentiating bony tumors and to call further attention to the value of surgical treatment in the benign giant cell tumors.

The etiology of fibrocystic tumors or foreign body giant cell tumors is still debatable. Virchow in 1876 ascribed their formation to liquefaction of chondromata. Rindfleisch in 1886 and Hirschberg in 1889 described these cysts as occurring in osteomalacia. Von Lechlinghausen in 1891 described general osteitis fibrosa cystica as a diffuse degenerating process of the long bone of metabolic origin. Beck in 1901 described two cases of cystic disease of the tibia which he believed due to trauma. Meyerding in 1918 emphasized the importance of infection superimposed on trauma as a probable factor in the production of fibrocystic tumor. Lewis in 1914 on account of the clinical behavior of the lesions expressed some doubt as to their neoplastic character and suggested the possibility of their being due to reactive tissue growth or to an attempt at repair following trauma in which excessive granulation tissue is formed or possibly the lesion in his opinion may represent a chronic reparative process with excessive formation of granulation tissue—not a tumor in the strict sense of the word. Lipke and Lubarsch reported findings originally and ascribed the formation of cysts to infection, a view held by Murphy and others. Other writers as Mueller, Feilner, Bloodgood, Beck, Silver, Fraiberg, Murphy, Percy, Lillie and Heinecke have discussed the probable factors which might produce osteitis fibrosa cystica.

Broders who made a pathological study of the tumors removed in both cases herein reported in a personal communication stated

Foreign body giant cell tumor have masqueraded under various names the two most common probably being giant cell sarcoma and giant cell tumor. Despite the fact that Mallory and others have called special attention to the two types of giant cell that occur in pathological process the distinction does not seem to be generally appreciated. The foreign body giant cell contains a large number of small regular nuclei of phagocytic nature is not neoplastic is closely related to the osteoclast and like the osteoclast when it comes in contact with bone it absorbs it. It is found in such pathological processes as tertiary syphilis, leprosy, blastomycosis, coccidioid, granuloma, tuberculosis, chronic osteomyelitis and giant cell tumor of bone, tendon sheath and gum. It is found also around cholesterol crystal, blood pigment, nonabsorbable suture material, colloid keratinized epithelium and so forth. It occurs occasionally in true sarcoma especially hemorrhagic osteogenic sarcoma.

The neoplastic or malignant giant cell has few large irregular nuclei and is found usually in case of highly malignant carcinoma or sarcoma. Foreign body giant cell tumor when found in association with tendon sheath are usually yellowish while those of bone are usually dark reddish, sometime liver like in appearance although they may be yellowish. The tumor especially those of the tendon sheath are rather firm while those of the bone and gum may be emolli. Microscopically foreign body giant cell may be numerous or few. Beside the giant cell there may be other phagocytic cells especially the foamy cell that are filled with lipid material, fibroblast, fibrous connective tissue, lymphocytes, a few polymorphous nuclear leukocytes, endothelial cells, numerous blood vessels and pieces of cholesterol crystal and blood pigment. The foreign body giant cell tumor is of a granular nature however it is not neoplastic. Because of the presence of foreign body giant cell it has an osteolytic property.

Its cause is probably extravasation of blood due to injury or infection

CASE I. A Jewish boy aged 14 years whose family history was negative for carcinoma, tuberculois and diabetes complained of paralysis of the lower extremities at the time of admission to the Clinic and stated that he had been well until 6 months before when he experienced pain in the region of the right side of the lower dorsal spine subsequent to corrective measures advised by his gymnasium instructor for what he believed to be curvature of the spine (kyphosis). In giving a description of the pain he stated that the whole back felt sore at times but that there was a steady pain in the region of the lower margin of the ribs dorsally on the right which would occasionally shoot across to the left side in a similar area. The pain affected the floating ribs he said and radiated around these ribs to the middle of the abdomen. In describing the pain in closer detail he said that it was neuralgic like, was more or less constant, dull and aching and was relieved occasionally by lying down. The pain continued without paralysis for 3 months when difficulty in urinating and incontinence of the rectal sphincter were noticed. Numbness over the legs and lower part of the abdomen was noticed 5 months after the onset; this soon became associated with dragging of the right leg. The weakness in the right leg advanced with the numbness until both lower extremities became completely paralyzed and there was loss of sensation below the umbilicus and difficulty in controlling both the bladder and the bowels. Malignant tumor at the tenth dorsal vertebra had been diagnosed previously.

The patient was a fairly well nourished boy of average size for his age and weighed 95 pounds. There was complete paralysis of the lower extremities and he had to be lifted about. The systolic blood pressure was 122; the diastolic 70. Heart and lungs were normal. Urinalysis was carried out on successive days; on the latter the specific gravity was 1008, the reaction acid and there were 12 pus cells to a field. The hemoglobin was 14, per cent erythrocytes numbered 4,600,000 and leucocytes 8,800. The differential count was 33.5 per cent lymphocytes, 60 per cent transitional, 61 per cent neutrophils and 1.5 per cent eosinophils. The combined phenol sulphonephthalein test showed a return of 30 per cent of the dye in 4 hours. The Wassermann test of the blood was negative. The pupils of the eyes were equal, the reflexes and the fields normal, the media clear, the ocular movements good and the fundi normal. Roentgen ray examination of the chest was negative. Roentgenograms of the dorsal and lumbar spines revealed destruction of the right half of the tenth dorsal vertebra with a more or less circumscribed shadow between the tenth and the eleventh ribs suggestive of tumor and multiple shadows were noted in the left renal area with calcified vertebral lymph nodes opposite the third lumbar vertebra on the right (Fig. 1). There was

tenderness with rigidity over the lower dorsal spine. On neurological examination the cranial nerves were normal as were also the brain and the spinal cord down to the tenth dorsal segment. From the tenth dorsal segment caudally motor power was completely lost. Pain, tactile and temperature sensibilities were impaired, being graded -3. The reflexes above the tenth dorsal segment were normal but were exaggerated below more so on the right than on the left. The diagnosis was obviously compression myelitis due to tumor. Because of destruction of the body of the tenth dorsal vertebra on the right it was surmised that the lesion might be a myeloma or giant cell sarcoma or a foreign body giant cell tumor of the osteitis fibrosa cystica type.

Exploratory laminectomy was advised and was performed August 18, 1914, under general anesthesia. The spines and laminae of the ninth, tenth and eleventh dorsal vertebrae were removed. An extradural mass was exposed which was found to involve the laminae of the ninth and tenth right dorsal vertebrae, the transverse processes of the same vertebrae and part of the tenth rib on the same side. The mass was definitely cystic and the surface was composed of a shell of bone. The cavity which extended into the bodies of the ninth and tenth vertebrae including the intravertebral disk, was curetted and yielded reddish pulpy friable clot-like material; it was not a simple hematoma but was reported by the pathologist to be a benign foreign body giant cell tumor with hemorrhagic cyst formation. As much of the shell like portion of the mass as was possible was removed and the contents of the rest of the cavity were curetted. The usual closure of the wound was made. Convalescence was uneventful and there was evidence of slight improvement in sensation prior to dismissal at the expiration of 3 weeks. As a precautionary measure a course of deep Coolidge tube roentgen ray treatment was carried out during the postoperative course. Numerous reports have been received from the boy and from his parents concerning his subsequent progress. In a letter dated January 16, 1915, it was stated that the boy had improved materially and was able to walk with the aid of crutches. June 16, 1926, a report was received to the effect that he was able to walk and to get about and that there had been improvement in all functions but that as yet he was unable to work. The last report was received April 8, 1927, from the boy himself in which he stated that he had been going to school and expected to be graduated from high school in June, 1927, that he was able to walk, run, hop on one leg, bend his body forward, backward and sidewise and stand erect without curvatures, that he was free from incontinence of urine and feces and that there was no numbness or weakness of any sort. In other words, convalescence had been uninterrupted.

In the light of the other discussions on foreign body giant cell tumors of the fibro

cystic type this patient should continue in good health and it is unlikely that other similar lesions will develop. Probably trauma was the important factor in the production of the lesion in this instance.

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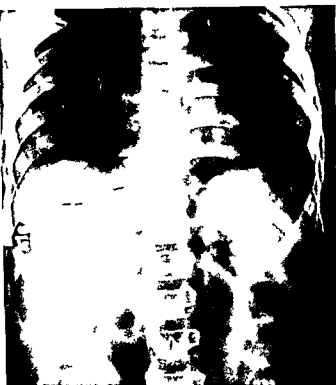


Fig. 1 Lesion of the tenth dorsal vertebra on the right



Fig. 2 Foreign body giant cell tumor of the upper cervical area (anteroposterior view)

had had previous to the injury and which apparently were of the nature of migraine the mother too is subject to migraine headaches. The cervical spine was again examined roentgenologically. There was no evidence of tumor only slight asymmetry in the cervical spine was present.

This case is worthy of consideration since a lesion like that in Case 1 would have progressed no doubt until complete transverse myelitis had developed. Again trauma and infection were etiological factors in the production of the tumor. The roentgen ray examination was of extreme value since it demonstrated the shell like tumor which made the diagnosis of foreign body giant cell tumor possible and encouraged us to perform the second exploration.

DISCUSSION

Lewis in reporting his case reviewed briefly the histories of 16 additional cases all of which were similar to the 2 I have presented. With one exception all of the patients were between the ages of 7 and 5 years.

In attempting to differentiate foreign body giant cell tumor and malignant tumor of the spine especially in children and young adults



Fig. 3 Lateral view of tumor shown in Figure 2. The fibrocytic nature and its attachment to the second and third cervical vertebrae are shown. The shell like appearance of the tumor and cystic areas containing irregularly placed spicules of bone are evident.

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THE VALUE OF VENTRICULAR STUDIES OTHER THAN VENTRICULOGRAPHY IN THE LOCALIZATION OF BRAIN TUMORS¹

By FRANCIS C GRANT M D PHILADELPHIA
I t t S g y U ty f P y l M l S h l

NO single factor is more vital to the successful extirpation of a brain tumor than precision in its localization. If the position of the neoplasm is accurately known the operative maneuvers necessary to its removal may be carried out with a much greater chance of success. The methods of determining that region of the brain involved by the tumor are many and varied. A careful detailed history with the chronology of the onset of the symptoms plus routine neurological studies, retinoscopic examinations and visual perimetric tests coupled with vestibular studies and roentgenoscopic films will furnish in the majority of instances clean cut evidence of the site of the neoplasm. However in a certain number of cases although the presence of a tumor is unquestioned no definite clue can be obtained as to its situation. Heretofore to solve this problem of the unlocalizable brain tumor a ventriculogram was necessary. But as experience with ventriculography increased the effect upon the size, shape and position of the ventricles of tumors placed in different brain areas became more clearly appreciated. It soon became apparent that if a definite routine were adopted in the tapping of the lateral ventricles the estimating of the amount of fluid removed from each and the determining by injection of a dye whether the interventricular foramina were patulous

a very shrewd guess could be made as to the abnormality in the ventricular outline that the X ray films would subsequently reveal. This procedure of attempting to determine the position of the lateral ventricles by plunging for them from a fixed point of estimating their relative size by the amount of fluid recoverable from each and lastly of discovering whether or not the interventricular foramina are patulous by the injection of a dye has been termed by Dandy (1) ventricular estimation. It is a logical outgrowth of his brilliant conception of cerebral pneumography. Since bilateral ventricular tap without the replacement of the fluid by air is unquestionably safer than ventriculography this has seemed sufficient justification to attempt to discover the value and the limitations of this less hazardous method of tumor localization.

Four conditions must be met in order to draw accurate conclusions from ventricular estimation. It is necessary to appreciate clearly the effect upon the ventricular system of a tumor in different regions of the brain. The operator should be thoroughly familiar with the normal position, size and depth from the surface of the lateral ventricles so that he can be certain that a failure to reach either of them is due to an abnormality in their outline and not to an error in his technique. The patient must be sufficiently cooperative to permit of a complete neurological study so

introducing the cannula that positive evidence of changes in their position may be determined. Bilateral trephine openings are made 7 centimeters above the occipital protuberance and 1.5 centimeters lateral to the midline to avoid the longitudinal sinus. The cannula is directed to enter the vestibule of the lateral ventricle its widest point. The occipitoparietal approach is used because the cannula passes through a relatively silent cerebral area well behind the sensory cortex and above the visual tracts. From this position the ventricles should be encountered at a depth of from 4 to 5 centimeters, the cannula being directed slightly outward and in a horizontal plane level with the tip of the ear. A shift in the position of a ventricle may be demonstrated by variations from the normal planes necessary to enter it with the cannula.

A complete neurological examination performed upon a cooperative patient is necessary to obtain the most accurate results from ventricular estimation. The negative evidence



Fig. 4. X-ray of Case 2 one year postoperatively after retapping of the cyst and replacing the fluid with air. The position of the cyst in the left frontal lobe is clearly shown.

of unimpaired functions from various cortical areas demonstrating that they are probably not involved by the tumor must always be considered. For example if it can be shown definitely that one lateral ventricle is much smaller than the other obviously the tumor cannot be cerebellar or in the third ventricle because a symmetrical hydrocephalus does not exist. The neoplasm must lie in that cerebral hemisphere harboring the smaller ventricle. And if all the active cortical areas of that hemisphere function normally the tumor must be located in a silent area for example the frontal lobe or the right temporal lobe.

In many instances where the clinical evidence is open to more than one interpretation as to the location of the tumor for example when doubt exists as to whether the lesion is in the frontal lobes or cerebellum ventricular estimation may clear up the situation at once by determining the presence or absence of hydrocephalus. Once it is known whether the tumor lies above or below the tentorium the proper localizing symptoms may be stressed while the confusing signs can be confidently rejected.

In a series of 6 cases in which ventricular estimation had been employed as an aid in diagnosis 19 were subsequently verified at operation or necropsy. Our interpretation of the findings was correct in 18 instances, incorrect in 1 instance. One death occurred in a patient already stuporous from intra-

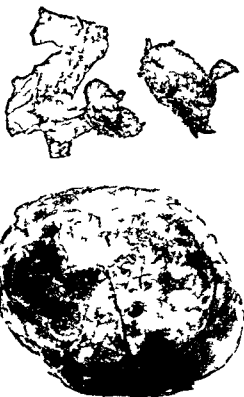


Fig. 3. Tumor removed from Case 1.



Fig. 1. Lateral ventricle dilated and shifted by tumor.

that by obtaining normal response from the different brain areas it can be determined which of them because of their unimpaired function are obviously uninvolved by the tumor. Lastly the possibilities of error inherent in this method must be grasped so that if necessary air may be introduced to outline the ventricle accurately if the evidence from an examination alone seems inconclusive.

Broadly considered brain tumors produce two types of change in the ventricular system—symmetrical or asymmetrical variations in the size, shape and position of the lateral third and fourth ventricle. Symmetrical dilatation of the lateral ventricle is always due to an internal hydrocephalus set up by a tumor obstructing the free circulation of the cerebrospinal fluid. To produce such an effect a tumor must be situated in the midline between the cerebral hemispheres either in or impinging upon the third ventricle supratentorially or in the posterior fossa (Fig. 1). Ventricular examination under the circumstances would reveal the lateral ventricle in normal position or nearer the cortex than usual. Both ventricle should show an increase in fluid content to approximately the same degree. Dandy states that it is necessary to obtain at least 10 cubic centimeter of fluid by free flow or apiration from each ventricle to be able to infer that a hydrocephalus exists.

It is particularly in case of hydrocephalus that injection of indocarmine dye into one

lateral ventricle may give important information. If under these conditions this indicator be injected into one lateral ventricle and can not be recovered from the other this is good evidence that the interventricular foramina are obstructed and that the tumor lies in this region.

Asymmetrical variations in the ventricular outline are always due to a tumor lying within one cerebral hemisphere and causing a shift in the position of one or both lateral ventricle with filling defect in the outline or even complete obliteration of the ventricle lying within the hemisphere involved (Fig. 2). Such changes are due to direct pressure from the neoplasm and not to secondary effect from interference with cerebrospinal fluid circulation. Under these conditions it may be impossible to introduce the exploring cannula into one or the other lateral ventricle. If both can be tapped the ventricle on one side contains much more fluid than its fellow—definite evidence of their inequality in size.

The ventricle should always be tapped from the same relative position. It is only through the development of an accurate technique in



Fig. 2. Lateral ventricle obliterated by tumor.

openings were made over the vertex. The left ventricle could not be reached. The right ventricle was readily tapped and 6 cubic centimeter of fluid were obtained. The left ventricle was therefore obliterated. Asymmetrical lateral ventricles existed and the tumor could not be located in the posterior fossa. A left frontal craniotomy was therefore performed and a large meningioma (Fig 3) arising from the left olfactory groove was removed. Convalescence was uneventful. Sufficient vision was regained in the right eye for the patient to see to thread a needle.

It is in the differentiation between subtentorial and supratentorial tumors that ventricular estimation is of peculiar value. Once ventricular asymmetry has been determined the tumor is known to lie above the tentorium.

CASE Marked evidence of intracranial pressure without definite localizing signs. A ventricular tap showed that the left ventricle was obliterated. A left frontotemporal flap was turned back and a glomatous cyst was exposed and evacuated.

R. B. a Jewish housewife was referred to the University Hospital on July 2, 1925 complaining of weakness and loss of vision. She had been entirely well until December, 1914, when she began to suffer from very severe frontotemporal headaches. Early in 1925 rapid failure of vision followed. In March, 1925 a right subtemporal decompression was done at another hospital in an attempt to preserve vision. Following this procedure the headaches disappeared but the visual loss steadily progressed. There has been no evidence of motor loss or convulsions but 6 weeks before admission a transient attack of unconsciousness occurred. There was some mental deterioration with a thick uncertain speech and drooling of saliva. During the preceding week she had become much weaker and had difficulty in getting about. Her gait while weak had never shown any suggestion of staggering. She had much difficulty in swallowing solid foods.

Physical examination revealed an undernourished woman rather uncooperative and silly in her talk. Her gait while weak was not abnormal. No Romberg sign was noted. Her memory was much impaired. The speech was rambling and occasionally disjointed but the presence of actual aphasia seemed questionable. There was a fair sized tense hernia cerebri on the right. The cranial nerves were negative except for questionable bilateral loss of sense of smell, occasional lateral nystagmoid movements of the eyes in both directions and bilateral choked discs of 5 diopters. The fundi were full to rough tests. The extremities revealed uniform weakness without sensory loss. No dysmetria ataxia, adiadochokinesis or astereognosis could be demonstrated. All reflexes were equally exaggerated. A bilateral Babinski, Oppenheim and abortive ankle clonus were noted. The roentgen ray studies were negative. A diagnosis



FIG. 7. Ventriculogram showing the effect of the tumor *T* of the left lateral ventricle on the ventricular system. Ventricular tap alone under these circumstances would have led to error in diagnosis because symmetrical hydrocephalus would have been found and a subtentorial lesion suspected. Localization of the tumor was determined by ventriculography and verified by the removal of the tumor at operation.

of cerebral tumor was made but with uncertainty as to laterality.

Doctor Grant attempted a bilateral ventricular tap through the parieto-occipital approach on July 8, 1925. The right ventricle was found to be in a normal position and contained 24 cubic centimeters of fluid. The left ventricle was reached but only cubic centimeters of fluid could be obtained. Pressure over the hernia cerebri seemed to increase the flow from the right ventricle but not from the left. **Impression**—asymmetry of lateral ventricles with obliteration of left tumor in silent area of left cerebral hemisphere.

On July 14, 1925 a left frontal flap was reflected revealing a large glomatous cyst. An evacuation of the cyst (Fig 4) was carried out with treatment of cyst wall with Zenker's fluid and removal of part of the deep lying tumor for pathological identification. This was followed by a decompression at the base of the flap. The patient recovered and was discharged. A pathological diagnosis of oligodendroglioma was made (Fig 5).



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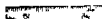


Fig. 6 Ph t f h f t h t m h h m d
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cranial pressure due to a large infiltrating glioma

The following case is illustrative of the value of ventricular estimation. That the case should all have harbored frontal lobe tumor is not a matter of chance. The frontal lobe are silent brain areas. Lesion in other region of the cerebral hemisphere usually produce definite clinical symptoms which make localization possible by ordinary method.

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g r t h p t t r l

M B a f m r f 4 o f g e r d
m t t l t h N u S u r g i s f t h l
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b D t r L o g f S t a t v i l l N o t h C a l n a H r
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(Fig 7) shows the hydrocephalus produced by a tumor lying within the left lateral ventricle. Had only an estimation of the size of these ventricles been made the conclusions based upon the test would have been grossly misleading. Furthermore the differentiation between midline supratentorial and posterior fossa lesions is not possible by bilateral tap alone for both produce symmetrical hydrocephalus. The only method by which this distinction can be made is through air injection and a determination of the presence or absence of air in the third ventricle. Furthermore this differentiation is of importance because the operative approach to the two regions is so radically different.

In any intracranial procedure release of intradural tension by ventricular tap will reduce hemorrhage and make possible a proper approach to the lesion thus greatly facilitating its extirpation. It is always a wise precaution therefore to know something of the size of the ventricle before attacking any tumor no matter how positively its position may be known. Furthermore if in a suspected cerebellar case a tap for relief of pressure fails to demonstrate a hydrocephalus the operator must be very certain

of his ground on clinical or other evidence before he explores the posterior fossa for in the presence of increased pressure cerebellar tumors always cause hydrocephalus.

CONCLUSIONS

1. Ventricular estimation is a safer procedure than ventriculography. In experienced hands with proper interpretation it may often give information of equal value.

Asymmetry of the lateral ventricles is very strong evidence of a cerebral tumor on the side of the smaller ventricle.

2. A symmetrical hydrocephalus usually indicates a cerebellar tumor. However it is under the circumstances that an error may be made from ventricular estimation alone unless the clinical syndrome points to the cerebellum. If doubt exists it is wisest to perform a ventriculogram in the presence of hydrocephalus.

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The first real clue to the position of the tumor was furnished by ventricular estimation. The relatively marked difference in the size of the ventricle was clear evidence that the tumor lay in the left cerebral hemisphere compressing the left lateral ventricle. Since the neurological signs were so few, the neoplasm was known to lie in a relatively silent area of the brain. The frontal region seemed almost certainly the seat of the tumor for the visual field, although of very questionable value, appeared full and furthermore, in performing the tip in the parieto-occipital region no encounter to the exploratory needle suggested a tumor was encountered. By the process of exclusion the neoplasm was concluded to be in the left frontal lobe.

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Here again the question of the localization of the tumor below or above the tentorium was solved by ventricular estimation. Furthermore, the tumor was located in the right cerebral hemisphere. All of the active areas of this hemisphere gave normal response; the neoplasm must of necessity have been situated in a silent area—the right frontal lobe.

In order to evaluate properly the usefulness of any test its limitation must be clearly understood. Ventricular estimation may easily lead the surgeon into error unless certain facts are taken into consideration. If ventricular asymmetry can be surely demonstrated this is certain evidence of a cerebral hemisphere tumor situated on the side of the smaller ventricle. If the ventricle are undilated equal in size and normal in position the lesion is probably not cerebral. It may be a cerebellar tumor which has not obstructed the cerebrospinal fluid circulation sufficiently to cause hydrocephalus. At times the posterior horn of the lateral ventricle may be absent as pointed out by Penfield (1). This may be deceptive for the ventricle apparently has disappeared in the hemisphere and may remain undilated even though a moderate hydrocephalus exists. We have observed a case in which a cerebellar tumor was ruled out because of absence of the posterior horns led the operator to believe that no hydrocephalus was present. A ventriculogram later corrected the error and demonstrated a fair degree of bilateral hydrocephalus with absence of the posterior horns. An intracranial tumor was later successfully removed.

If hydrocephalus exists it is wiser to perform a ventriculogram and attempt to localize the tumor exactly unless the clinical evidence is overwhelmingly in favor of a posterior fossa lesion. The accompanying roentgenogram

flexes the pains strengthen and rotation of the occiput to the front takes place rapidly. If the patient merely changes her position in bed or gets up to go to the toilet this favorable mechanism may be started.

Beyond question it is better for the mother and safer for the baby to have anterior rotation of the occiput take place and the birth occur with the usual anterior mechanism. This statement is made though I am well aware that a certain percentage of cases of occiput posterior terminate as such spontaneously with the small fontanel coming out over the perineum and also that a certain number of accoucheurs do not believe in effecting anterior rotation before they attempt delivery. Only when our attempts to correct the abnormal position fail do we consent to deliver the occiput over (usually through) the perineum.

The methods of dealing with persistent occiput posterior positions are numerous. Hodge's maneuver consisting of upward pressure on the symphysis during the pains. Tarnier's maneuver the attempted rotation of the head with the fingers which obtain a purchase behind the ear the same aided by backward pressure on the cephalic prominence above the pubis (the forehead) rotation of the head in the pelvis by combined manipulation under an anæsthetic the whole hand being used internally the pushing of the head up out of the pelvis and the rotation of the whole fetal body by twisting the child's trunk to the opposite oblique podalic version the use of the forceps as a rotator or as combined rotator and deliverer.

In the majority of cases it is possible to turn the head in the pelvis by means of the hands at least so far as to bring the small fontanel from the hollow of the sacrum O 180 degrees into an anterior quadrant of the pelvis O L 45 degrees or O D 45 degrees. Then one can easily finish the rotation and the delivery with forceps.

With the patient under deep anæsthesia the whole hand is inserted and the head is gently lifted up out of its imbedment in the soft parts. It makes little difference which hand is used inside the pelvis though in O L P I usually put the left hand in behind the pubis and press backward on the forehead lying there with the fingers or if it seems easier I twist the wrist so as to insinuate the fingers underneath and behind the occiput lying on the left side the thumb pressing on the side of the forehead. By the supinating of the hand the head is turned into the transverse. Now the fingers are quickly withdrawn part way the hand reversed so as to bring its dorsum behind the pubis the fingers resting on the malar bone

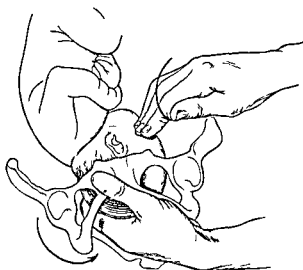


FIG. 1. Changing a right occiput to an anterior position by combined manipulation.

and by a supinating movement pressure on the forehead is exerted sweeping this part of the head through the right half of the pelvis toward the sacrum. Thus the occiput comes to lie near the pubis. This maneuver succeeds best when the head is partly deflexed. When flexion is well established it may be (it is not always) better to work on the occiput directly.

In O L P (O L 135 degrees) with flexion the right hand is laid behind the head with the volar side of the fingers upward and by a pronating twist of the wrist combined with flexion of the fingers the occiput is levered to the front. All the movements are aided, abetted, modified and controlled by the outside hand and the turning of the head is made easier by lubricating it and the vagina with green soap (Fig. 1). It is also advisable to have the head of the patient 3 or 4 inches lower than the pelvis in order to prevent prolapse of the cord when the fetal head is raised up.

One is often disappointed to find that after the head has been turned into an anterior sector of the pelvic circle before the forceps can be applied indeed often before one withdraws the hand the occiput slips back into its former malposition. There are several ways of handling such a situation. (1) have the assistant by a hand above the pubis press the forehead backward and hold it while you apply the forceps (not very successful). (2) have him try to turn the baby's back anteriorly or indeed a little beyond the midline and press down on the fundus to favor flexion etc. (also not very successful). (3) the operator can after turning the head as far as it will go withdraw his hand and neatly slip in the other one behind the pubis to press the forehead back. (4) he may

CLINICAL SURGERY

FROM THE CHICAGO LIVING HOSPITAL

THE TRIANGULAR OCCIPUT POSTERIOR POSITION AFTER ENGAGEMENT OF THE HEAD

By JOSEPH B. DILLIE, M.D., I.A.C.S., C.

In a hitherto article on technique it is not possible to cover the whole subject of the treatment of occiput posterior position, and therefore I have collected no phrase but the most common one, that the head has engaged in the pelvis but anterior rotation of the occiput has failed to take place. In fact the occiput may have turned further backward after descent and this must result in the hollow of the sacrum with the small fontanel in the median line.

In recent local little venting precisely to our definition of the various positions the presenting part occupies in the pelvis I have recommended that we name the positions according to the degrees of arc around the vertical line of the pelvis. Thus when the occiput lies as just described we would term it an occiput 180 degree right or left depending on which side the occiput came down. Occiput right transverse would be O.D. 90 degrees, occiput left anteroposterior O.L. 45 degrees, etc.

As a rule in practice we find that a head which comes into the pelvis O.D. 135 degrees or O.L. 135 degrees (i.e. O.D.P. or O.L.P. respectively) will if given time enough rotate spontaneously the rest of the half circle and come to lie O.D. 45 degrees or O.L. 45 degrees or 0 degrees, whence it will be delivered spontaneously or by the aid of a simple forceps operation. Since this may require many hours of labor the accoucheur should support the parturient's power with food especially sugar and fluid and with rest and sleep. Morphine and potassium morphine and magnesium sulphate with or without either rectal instillations are to be used generously. The ligamentous multiple pericervical nodes as possible in ruptured and complete dilatation of the cervix have been drained. There are exceptions to this rule but they are rare. The patient should lie on only on the left with the occiput point but the head chin to the left. The rectum and bladder are to be kept empty.

Slow dilatation of the cervix may be due to primary inertia of the uterus or to abnormal action of the uterine muscle or the formation of contraction rings and strictures. These multiple differentiated. The treatment of course varies. In the one we will stimulate in the other tranquilize the uterus. Early in the first stage a dose of castor oil with 3 to 5 grains of quinine may be given. The nasal application of pituitary extract according to Hofbauer's method may be tried but the accoucheur must stand ready to remove the packing and give ether at once when the pains get too strong and endanger the mother or child. I seldom employ this remedy. Narcotics are the least for strictured uterus they may be aided by atropin in physiological dose.

In the olden time we obtained much benefit from the following procedure: the parturient is given a hot bath (now superseded by a hot wet pack) then a generous alkaline rub then an enema of 30 grains of bromide of soda and 15 grains of chloral then a drink of hot lemonade finally 6 to 4 grain of morphine the room was darkened and quieted. A refreshing sleep lasting 6 to 10 hours usually resulted and dilatation as the result of insensible labor was often found nearly complete when the pains began again.

Should medical treatment fail the dilatation of the os can be hastened by packing the cervix in vaginal vault with gauze saturated in glycerine to which 1 per cent mercuric chrome has been added or by metreurysis.

Let us say that the parturient has been carried to the point where the cervix is completely dilated or to a diameter of 8 or 9 centimeters and by means of Dehrssen's incisions the opening can be safely enlarged to permit extraction of the child. Now what to do.

First one must be convinced from the character of the labor up to this point that the woman will not be able to end the process herself. It is well to be prepared for surgery as occasionally the head

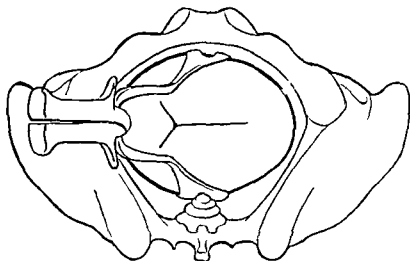


Fig. 3. Forcep applied to the head ODT (OD 90 degrees) with the blade in the anteroposterior diameter of the pelvis. The head is grasped ideally but there is danger to the mother's soft parts.

use the hand which effected the rotation internally to hold the head at the point of rotation gained until one blade of the forceps can be applied and thus acting like an old-fashioned vectis will keep the head in its new position or indeed may increase the rotation. (5) he may fix the head at the furthest anterior point of rotation by means of a vulsellum attached to the baby's scalp. He should be sure not to try to turn the head with this instrument; it will tear out a piece of skin—merely hold the head steady with it—thus employed no harm will result.

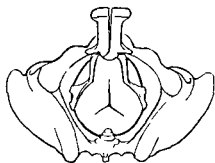
Should manual rotation fail which very seldom happens if one goes about it *lege artis*, resource must be had to the forceps. Let me repeat this article deals with the abnormal position *after* engagement. Before the head has sunk below the inlet version is usually the choice. The operation of forceps in persistent occiput posterior positions may be very easy and very hard. Much depends on individual skill and considerable also upon the conformation of the pelvis and soft parts and the size of the baby and pelvis.

At the very outset of the discussion of forceps in occiput posterior positions we meet this question: May the forceps be used as a rotator or is it to be simply a tractor adding to the downward movement of the head only that amount of rotation which nature gives the head in its passage its progress being thus made a turbinal motion?

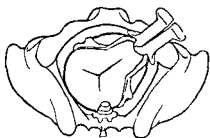
Levet in 1746 said that the forceps should be a tractor and nothing else to supply from below the force that was lacking from above. Smellie in 1755 used his short straight forceps as a rotator. Scanzoni in 1865 developed an operation in which instrumental rotation was the main

feature. Tarnier in 1881 demonstrated the principle on which the forceps may be used to correct the position of the head in the pelvis. He pointed out that because of the pelvic curve of the instrument if one twists the handles the blades with the head in their grasp do not turn on the axis of the shanks but tend to describe part of a circle within the pelvis. In order therefore to make the head rotate around an axis it is necessary to sweep the handles of the forceps through a large circle outside the pelvis. The apex of the forceps blades then will act as a center and the head will turn around on it. Bill has improved on Tarnier's maneuver by first raising the head out of the pelvic floor gutter and then sweeping the handles around to impart the movement of rotation to the head within the pelvis. Kielland in 1915 devised a forceps without pelvic curve and with the blades bent a little downward. With this instrument a head may be grasped biparietally no matter in which diameter it lies in the pelvis and it may according to Kielland be twisted safely to any position desired.

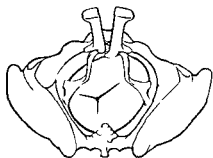
The dangers of using the forceps as a pure rotator as Scanzoni and Tarnier did are the vagina and bladder may be torn from their attachments to the fascia and the bony pelvis. Hematomata may be produced in the areolar tissue at the bases of the broad ligaments, the ureters may be stretched and the baby's head and neck may suffer damage. If the head is pushed up too far the cord may prolapse necessitating a hurried forceful and destructive extraction. With these things in mind I have devised a method of rotation of the head which combines several of these well-known maneuvers and for want of a



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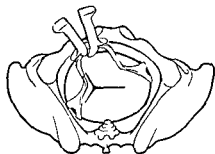
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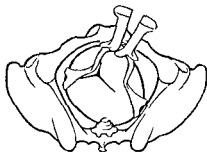
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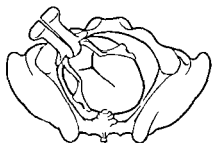
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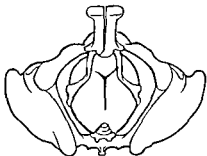
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t l j th oc p t t t t l th f p bld

better term I have named it the key in lock operation. It really tries to imitate nature's process of push twist retract untwist and repeat but we have to do them in reverse—push up twist pull and repeat. We try to impress a wriggling motion on the head which is not easy to describe.

With the head lying in the right oblique diameter O D 135 degree the forceps blades are laid in the transverse of the pelvis. They will grasp the head diagonally in an unfavorable manner and are therefore to be held very delicately. Now under the slightest possible compression the head is pushed up about centimeters in the axis of the birth canal and gently twisted the small fontanel being brought forward not more than 5 degrees. This is done by sweeping the handles of the forceps through an arc of about 10 degrees outside the pelvis *à la methode Tarnier*. Then the head is pulled down a little in the axis of the pelvis but less than it was pushed up. I repeat this maneuver two or three times pushing the head up only as much as you pull down and when the sagittal suture is transverse i.e. O D T or O D 90 degree the front of the forceps will now point to the left and they will lie in the left oblique. Readjust them so that they will come to lie in the right oblique grasping the head in a more favorable diameter than is the ideal manner. Indeed sometimes the head slips around the rest of the way itelf within the blades. By pushing up a little twisting a little and levering a very little (to overcome asynclitism) imparting a wriggling motion to the head not unlike fitting a key into a stubborn lock one can usually coax the occiput to the front whereupon the rest of the operation—the extraction is completed without trouble. One should not hurry nor do too much turning, at once not more than 5 degrees it is like taking mince pies. Readjust the forceps *par sa* as the rotation is effected (Fig. A to H).

The prehension of the head at the beginning of this operation need not always be made as described. Variants must be recognized but the principle does not change. Sometime it is possible to lay the blades to the head anteroposteriorly in the pelvis with their front directed toward the small fontanel (Fig.) Again one may apply the forceps with the front toward the fore

head (as in the Scanzoni maneuver) and when the occiput is brought into the anterior quadrant of the pelvis remove them and reapply as for an anterior position.

In rare cases it is impossible to turn the occiput to the front either by manual effort or by the forceps or by a combination of the hand with the forceps. To force the issue would entail great damage to the mother and probably kill the baby, therefore we must observe and discover the mechanism intended by nature and then aid it. If the occipitosacral mechanism is inevitable it is best to deliver the head in extreme flexion.

The application of the blades is made as usual but the front of the forceps looks toward the forehead which from now on becomes the point of direction. Locking the blades is the same as usual but after they are locked the handles are raised a little toward the pubis in order to increase flexion. Traction is made on the parietal bosses a little upward from the horizontal plane. This increases flexion and it has happened though I have never observed it that even as late as this anterior rotation has occurred. The occiput is first delivered over the perineum the forehead rests behind the pubis then the brow and face come from under the pubis. Much power is often necessary and it is advisable to perform episiotomy in primiparæ as a rule and almost always in multiparæ to avoid extensive lacerations of the pelvic floor and sphincter. If conditions are favorable one might deflex the head and deliver as a face presentation. These cases are claimed by the Kulland forceps enthusiasts. Some accoucheurs prefer the axis traction forceps since the mobility they confer on the head allows the latter to adapt itself somewhat to the parturient passage but for the man who knows the mechanism of labor and is willing to be guided by the action of the natural powers they are unnecessary and in the hands of a man ignorant of the principles of obstetrics the instrument is too dangerous.

In cases in which great difficulty is experienced an overlooked funnel pelvis will often be found and the accoucheur will regret that he attempted delivery from below. Here again one should emphasize the necessity of careful antenatal examination and prepartal decision as to the method of conduct in the approaching labor.

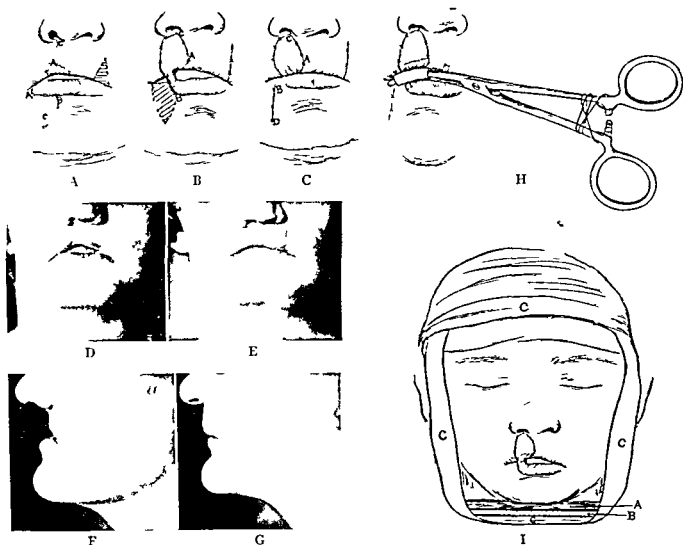


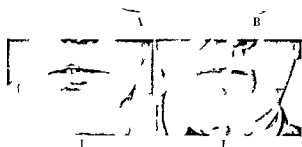
FIG. 4. Plan 4—Used for filling in defects of the upper lip at or close to the center. A A C Line of opening lip to receive flap. ABC flap raised in lower lip. The shaded triangle at the left corner of the upper lip is removed and the defect resutured to correct the deformity shown in D. B Flap ABC in place in upper lip with the pedicle still attached to the lower lip at B through which the blood supply goes. This pedicle is cut in from 2 to 3 weeks after the vitality of the flap is tested by clamping the blood supply through the pedicle. Further adjustment of the vermilion of both lips is necessary, but may be delayed for some time after the pedicle is cut if advisable. The defect in the lower lip is left open in this drawing, to show the course of the pedicle. C Pedicle of flap has been cut and the vermilion of both lips adjusted. BD Line of closure in

lower lip. D and E Shows a condition for which Plan 4 is used. F and G Same as Figure C and D. H Shows method of gently compressing the pedicle to shut off the vessels through it to the flap. This is to determine the adequacy of the blood supply from the new bed of the flap, and it is started about the tenth day. A rubber covered clamp is used and a rubber band is looped over the handles to obtain even elastic pressure. The catches on the clamp are used to hold the rubber band. I Shows method of holding the mouth shut. The head is padded and a plaster cap is put on that holds the plaster sling from the chin. This has been found to be the most comfortable arrangement although a silkworm gut stitch from one lip to the other that does not interfere with the blood supply has been used satisfactorily.

usually between 2 and 3 weeks and before cutting it the new blood supply is tested by compressing the pedicle with a rubber-covered clamp for an hour or two (Fig. 4 H). If after several hours of compression repeated on several consecutive days the color of the flap while the pedicle is compressed remains doubtful it may be well to divide the coronary artery in the flap but postpone the cutting of the rest of the flap until the new circulation is satisfactory. A flap switched

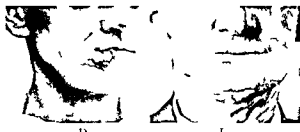
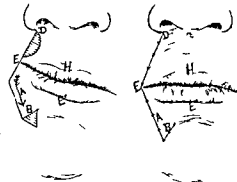
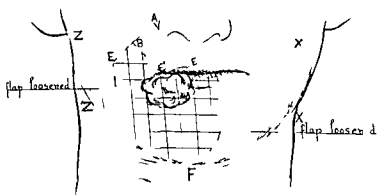
into a scar bed may be slow in gathering its new blood supply. This compression should be gentle to avoid cumulative trauma. A plaster cap with a padded plaster sling down around the chin is the plan used for holding the mouth closed to prevent damage to the pedicle (Fig. 4 I).

The area to be excised or to be filled in and the flaps used for repair are to be carefully planned. Accuracy in this point will be evidenced in the result. The blood supply of the flap must be kept



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A

Fig. 1 A Pulmonary abscess of 3 months duration (postpneumonic) B After 4 bronchoscopic aspirations



B

Clinical symptoms disappeared, patient gained 36 pounds and returned to work 4 months after onset of symptoms



A

Fig. 2 A Abscess of lung B After bronchoscopic treatments within 5 weeks



B

in mind while the flap is being cut as the pedicle consists of but little more than the vermilion border and the coronary vessels. The artery can be felt just under the mucous membrane.

There is seldom much trouble with function although there may occasionally be some leakage of fluids because of lack of sensation or of muscular action. With a little training this can usually be overcome. The patient should put his spoon or cup against the lower lip at the repaired angle and take the food in from there. This same method proves of value to those patients who have lost the inframandibular branch of the seventh nerve from other causes. Most of the patients operated on have satisfactory control of the mouth and

none of them has any leakage of saliva. More accurate data is being collected on the nerve regeneration and muscular action.

In general this plan tends rather satisfactorily to preserve some of the natural prominence and contour of the damaged lip and to prevent the excessive protrusion of its fellow that results from the obliteration of the original defect by the simple approximation of the borders.

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(Q t d b y J S D I l t S g n)

BRONCHOSCOPIC TREATMENT OF PULMONARY ABSCESS¹

By HERMAN J MOERSCH M D ROCHESTER MI ES A
D I Med M y Cl ac

PULMONARY abscess offers one of the most difficult problems in diagnosis and treatment. It has been estimated that approximately 50 per cent of the cases of untreated pulmonary abscess terminate fatally. Miller and Lambert² found that the mortality rates in surgery for pulmonary abscess varied between 10 and 60 per cent depending on the operator and number of thoracic operations he had performed.

It is fortunate that bronchoscopy has been of so much value in treating pulmonary abscess and has produced such splendid results. Although applied successfully only in recent years it has already surpassed our greatest expectations and now stands as the most valuable aid in the treatment of this condition.

DIAGNOSIS

Before the bronchoscopic treatment of pulmonary abscess and the results obtained are discussed it is necessary to define what is meant by pulmonary abscess. Unfortunately the term is mistakenly applied to many pulmonary conditions. It is easy to understand why these mistakes occur since even the pathologist with the specimen in his hands can not always distinguish accurately between a bronchiectatic condition and pulmonary abscess. A further complication is introduced by the fact that the older an abscess grows the more closely its structure resembles that of bronchiectasis also walled-off empyema

may simulate pulmonary abscess and may easily be mistaken for it.

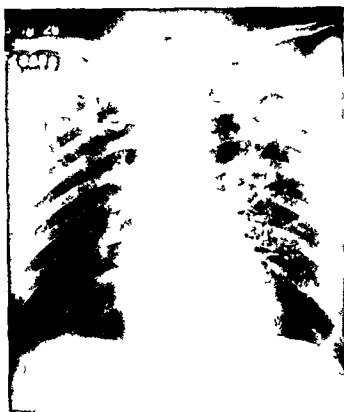
The necessity of distinguish between pulmonary abscess and other forms of pulmonary suppuration as far as possible is obvious because of the marked difference in their response to medical and surgical treatment. The possibility of relieving pulmonary abscess is far greater than that of relieving other types of pulmonary suppuration especially bronchiectasis. An abscess involves chiefly the parenchyma of the lung—tissues which are elastic and pliable and able to regenerate. After the cavity is drained its walls tend to collapse and healing takes place. Bronchiectasis chiefly involves the bronchi which are rigid tubes and do not collapse when pus is removed but expand in response to extrinsic and intrinsic forces. In time a pulmonary abscess becomes walled off by means of fibrous tissue which forms a rigid wall resembling the structure found in bronchiectasis. It is for this reason that pulmonary abscess of long standing is less amenable to treatment.

Clinically the diagnosis of pulmonary abscess is based on the history which is of the greatest importance on the physical findings on the roentgenogram and finally on bronchoscopic examination. While errors in diagnosis are relatively easily made in a condition such as pulmonary abscess especially in its differentiation from bronchiectasis still the cases in the group under consideration in this paper have been



A

Fig 4 A Pulmonary abscess of left upper lobe of indeterminate origin B Two weeks later after one



B

bronchoscopic aspiration Iodized oil (40 per cent) injected previous to bronchoscopy can still be seen

abscess I have never noted any ill effect from such a procedure. It is not advisable to probe into the pulmonary tissue through the bronchial wall in the hope of encountering the abscess; however, if one can be absolutely certain of the site of the abscess, he is justified in burrowing through normal lung tissue to reach it. Some bronchoscopists have feared that fatal hemorrhage might result from this procedure. However, I have found that although bleeding may occur, it is not severe. Blood vessels are undoubtedly torn, but because of the size and shape of the instruments used, they are more than likely torn completely across rather than partially torn. The ruptured end of a vessel torn completely across retracts and contracts more thoroughly; this is of prime importance in the control of hemorrhage.

REVIEW OF CASES

During 1915 and 1926, 19 cases of diagnosed pulmonary abscess were treated bronchoscopically with the following results. In 16, excellent results were obtained from bronchoscopic drainage. In 1 case, the result was indeterminate and the patient is still under observation. In 1 case, operation was resorted to as the results from bronchoscopy

were unsatisfactory. Death occurred in the case of a man whose symptoms had persisted for 1 year and were of indeterminate origin. He improved markedly after 2 bronchoscopic drainages and was permitted to return home. Four months later he died, but I have been unable to obtain information as to the cause of death. In the absence of definite information, I have attributed his death to the pulmonary trouble. Therefore, in the group under consideration, satisfactory results were obtained in 84 per cent. It is my belief, however, that with increased knowledge and improved bronchoscopic technique, this percentage will be increased.

The causes of pulmonary abscess in the 19 cases under consideration were as follows: pneumonia in 4, inhaled foreign body in 3, aspiration at tonsillectomy in 2, aspiration at dental extraction in 2, aspiration during other operations in 3, influenza in 1, secondary to aspiration in cardiospasm in 1, and some indeterminate cause in 3. The etiological factor seems to play an indefinite role in determining the prognosis in all of these cases.

The length of time that the abscess has existed is important in the prognosis. The duration of the disease in this group varied from 20 days to 6



A



B

I 3 A I t p t p l m v t f d y d t B T m t h f o b h p a p t

as definitely diagnosed pulmonary abscess is impossible by present diagnostic means

TREATMENT

It is extremely important that the bronchoscopist and the thoracic surgeon work in close harmony in cases of pulmonary abscess since complicating factors such as empyema may necessitate operation. The bronchoscopist on the other hand can often give the surgeon valuable information when operation is indicated. It is only through the correlation of bronchoscopy and surgery that the best results can be obtained.

The essential factor in the bronchoscopic treatment of pulmonary abscesses is in suppuration elsewhere in the body is sufficient and proper drainage. For some reason most bronchoscopists regard the lung as a friable and delicate organ which must be handled with the greatest care. When pus is to be aspirated or an abscess drained the aspirator is introduced through the opening in the abscess very gently and nothing is disturbed. If one considers the trauma to the lung in pulmonary operations or the ease with which the lung stands injury when foreign bodies are inhaled such precautions seem unnecessary in treating pulmonary abscess. First of all it is essential that the area of the abscess be definitely

located and this is usually possible from the appearance of pus in the bronchus draining the area involved. At times the site of the abscess is manifested by bulging or obstruction of the lumen of a bronchus due to inflammatory swelling. When the affected area is definitely located an aspirator is introduced into the bronchus from which the pus is exuding or which is obstructed by oedema and inflammation. If pus is obtained the aspirator is moved in every possible direction to insure the removal of pus from every accessible pocket. Abscesses may be divided into multiple small pockets and if the aspirator is moved about many of the barriers will be broken down thus insuring better drainage. If the opening into the abscessed area is so small or stenotic as to interfere with the free flow of pus it should be forcibly dilated with a heavy pair of dilating forceps. If necrotic or fibrous tissue obstructs the opening it should be removed with biting forceps. If the abscess is caused by a foreign body the offending material as well as any calcareous deposits that may have formed must be completely removed if the best results are to be obtained.

When the abscess does not drain into a bronchus but bulges into a bronchus one should not hesitate to introduce an aspirator directly into the



Fig 1 Case 1



Fig 2 Case 2



Fig 3 Case 3



Fig 4 Case 4

years. When the abscess had been present for a month or less excellent results were obtained from bronchoscopic drainage; this was also true of cases in which the symptoms had been present less than 3 months. Although abscesses of longer duration as a rule responded less rapidly to treatment this was not invariable as the abscess which had been present 6 years was cured by bronchoscopic treatment.

The number of bronchoscopic treatments necessary in these cases varies considerably. In 12 cases only a single bronchoscopic treatment as required in cases 4 were required. The number of treatments depends on the efficiency of drainage. There are many factors that must be considered before too definite conclusions are drawn concerning any particular procedure in the treatment of pulmonary abscess. Abscesses occasionally drain or rupture spontaneously with complete relief of symptoms although this is rare in those of long standing. In my experience

abscess of the right lung has been easier to treat than that of the left chiefly because of mechanical factors. The age of the patient has little influence on response to treatment. In the present series the ages varied from 10 to 74 years.

The illustrations demonstrate as well as the bronchoscopic treatment of pulmonary abscess. Because of pleural thickening it is difficult to obtain as accurate a conception of the improvement as from examination and clinical data.

CONCLUSION

1. Bronchoscopy is of paramount importance in the treatment of pulmonary abscess.
2. Remarkable results are obtained with little risk.
3. Time and expense consumed in treatment are reduced to the minimum.
4. Adequate and proper drainage is essential to success.

THE THERAPEUTIC VALUE OF LIPIODOL IN EMPYEMA

By J. LOUIS RANSOHOFF, M.D., F.A.C.S., and JOSEPH D. HEIMAN, M.D., Cincinnati, Ohio
F. M. H. G. I. Dep. M. T. J. H. I. I.

DURING the past 3 years we have treated acute empyema by closed intercostal aspiration drainage followed by 2 hourly instillations of Carrel-Dakin solution. These instillations are continued until all symptoms have subsided and the bacterial count of the secretion from the fistula is reduced to 2 or 3 bacteria per field. The tube is then removed and the wound allowed to close. Though this method has in the main yielded satisfactory results there has been a small percentage of cases in which this treatment was inadequate. In a few instances subsequent rib resection with open drainage has been necessary. This in a measure constitutes therapeutic failure as it results in long hospitalization, deformity, and possibly chronic empyema.

In January, 1927 we began using injections of lipiodol to determine the size of the residual cavity before removing the tube. It at once became evident that cases handled in this manner had an unusually uneventful recovery. In no case in which lipiodol was injected was it necessary to re-institute drainage or irrigation. The wounds were dressed and soon healed completely.

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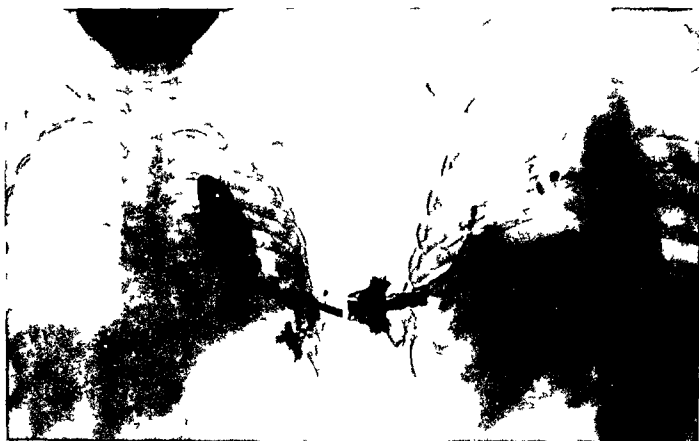


Fig 1 Case 1

Fig 2 Case 2



Fig 3 Case 3



Fig 4 Case 4

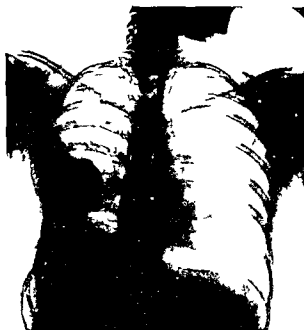


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j o d f m g u e O D m b 3 t h p c k
m o d d C a l D a k t i l l a t b e g u T h
c o t d u t l l b r u y 8 w h e l p o d l
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t t l p g e t d g p d d f w r d m
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c h t w a l l (F g 5) T h e i n t l l t o f l p o d l w p t d
o t h e c e d n d t h d d y T h w o d w d d
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d y l t t h w t r u t t d h w d d d y
T h w k l t t h w d w o m p l e t l y h l d

When it is determined that the bacterial count is reduced to satisfactory limits a sufficient amount of lipiodol is instilled through the catheter to fill the cavity. An X ray picture is taken the catheter clamped so as to retain as much as possible of the lipiodol in the cavity. As was shown in Case 2 the lipiodol instillations may be repeated with advantage. After 2 days the tube is removed and a simple dressing placed on the wound. No subsequent irrigations should be made. These results are interesting in the face of Archibald's article in which he disclaims any therapeutic or bacteriological properties of lipiodol.

CONCLUSIONS

In the 5 cases which have been reported 4 were acute and 1 chronic. All healed rapidly after injection of lipiodol. The chronic case is of particular interest since it was especially obstinate and a large cavity extended upward under the sternum and could not be satisfactorily exposed.

The injection of lipiodol into the residual cavity after treatment of empyema by aspiration drainage and Carrel-Dakin instillations seems to have a decided beneficial action. It is simple, free from danger, and should be given a trial.

ANGIOMA OF THE KIDNEY¹

By E STARR JUDD MD FACS AND HAROLD E SIMON MD ROCHESTER MINNESOTA
 Received May 11, 1934

ANGIOMA is the rarest of benign tumors of the kidney. Some observers have even doubted its existence and have ascribed the localized areas of extreme vascularity which occur in the kidney to congenital malformation, localized ectasia or trauma of the renal parenchyma. Cases have been reported however in which it is difficult to explain the observations on any basis other than that of true tumor formation. Whether these lesions are congenital or acquired remains problematic.

LITERATURE

The literature pertaining to renal angioma is limited almost entirely to case reports. We have been able to collect 11 which seem to be authentic (Table 1).

Virchow mentioned angioma of the kidney and believed that it occurred rather commonly, only less so than angioma of the liver. He reported angiomas of the kidney in conjunction with similar tumors in the liver.

Lutz reported the case of a man aged 6 years who for 5 weeks had suffered from hæmaturia originating in the right kidney. The kidney contained a tumor a little larger than a cherry stone situated at the intersection of the medulla and the pelvis. It was a spongy growth with great endothelium lined spaces, some of them filled with blood. Lutz also referred to several

cases which had been reported in the literature.

Stedry reported the case of a man aged 29 years. Hæmaturia originating in the right kidney had been present for 6½ years. Decapsulation was without effect and later the kidney was removed. It contained an area in the tip of a papilla composed of typical angiomatous tissue.

Swan reported a case from personal observation and referred to several cases in the literature.

REPORT OF A CASE

The patient was a woman aged 5 years. For 20 years there had been attacks of hæmaturia occurring every 4 or 5 years and lasting from 2 to 3 weeks. They were sometimes associated with left sided renal colic. The bleeding was at times so severe that the patient became weak and lost weight, but she always recovered rapidly after the bleeding ceased.

On examination she appeared healthy. Neither kidney was palpable. Cystoscopic examination demonstrated that there was less cretion from the left kidney than from the right. The left pyelogram was normal.

In view of the history of repeated renal hæmorrhage, often of alarming degree associated with pain which was always referred to the left side and of the reduced function of the left kidney, it was thought advisable to explore the left kidney. At operation the superior pole was found to be occupied by many dilated blood vessels and nephrectomy was performed. Convalescence was uneventful and 3 months later the patient was perfectly well.

The kidney was small. The capsule was stripped off easily and the surface of the kidney was granular. The tumor was situated in the cortex and occupied the upper pole. It measured by 2.5 centimeters and its outlines



Fig. Angioma of the kidney. The endothelium lined spaces filled with blood are shown. (X 100)



Fig. Tiny carcinoma of the kidney. The blood filled spaces are lined with epithelium. (X 150)

TABLE I—SUMMARY OF CASES OF RENAL ANGIOMA REPORTED IN THE LITERATURE

	A y)	S d	G d s c l	M TP s c p	Cl ymp m	R m k
I b l q ed	6 M	L f	N m m	C p l l r y g m	I m h g m h m	H y f y
I I k d	8 F	Lef	Cl l l r y f p l i p		H m t s	
I L k i l			A l l p l p p	Bloo i fill l l	bl d l y	
I	6 M	R ght	A l l m d l l f p l d m l 7 m m	F d h l m l d p l m l h l d	H m t l h l h ood	N h e c m h y
R l f d			I p l l 7 m m d		H m	
6 R l l h k d	6 M	L f	I f w l	R m l l f h m l ed	N	M k d l l f h h d p h l m f l
7 M	k	L f	M l l l m m	A s c l l p e s h l l h m s c l	I m d p y h m l	I h h r o f h
8 l y Wh l q i					H m	
j	M	R gh	m l l m p l l	C m	H m l a y h m l b s	Cl p l
	M	Lef	O l b m	A m l h d l d i l l	P f s e h m h g s	Em g y p w h
A h Wh l d			M l l l l p l l p l m	A g m		

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SYMPTOMS AND TREATMENT

Angioma may give rise to clinical symptoms there is practically always hematuria which usually occurs as a result of ulceration into the renal pelvis. The bleeding may be severe producing marked anemia and at times it may be so severe and prolonged that the patient goes into a state of shock. When the angioma is in the cortex it frequently produces no symptoms.

In the cases reported the only definite symptom before operation was bleeding without any obvious cause from one kidney. The side from which the blood escaped could be determined by cystoscopic examination. In several instances the diagnosis of essential hematuria has been made but when the bleeding continued and obviously was from only one kidney nephrectomy

was performed and the angioma found. Because of the peculiar lack of clinical evidence on which to base a definite diagnosis in these cases and because of the inaccessibility of these tumors at exploration except when they are situated in the cortex it frequently happens that the diagnosis cannot be made even with the kidney in view. In these cases nephrectomy has been performed because of severe or prolonged unilateral renal hemorrhage.

GENERAL DISCUSSION

It is generally conceded that angiomas probably never attain a diameter greater than 1 or 2 centimeters. In most instances they have been solitary but in the case reported by Morris they were multiple and situated in the medullary portion of the kidney while in the cases cited by Deane and Virchow they were multiple and situated in the cortex.

Unlike the other types of benign renal tumors which have a predilection for the cortical zone angiomas occur either in the cortex or in the medulla often in the papillae. They may or may not be encapsulated. In Morris case the tumors were definitely encapsulated. The age of the patients in the cases described in the literature has varied from 18 to 66 years the average was 38

years. In 7 cases the sex was mentioned 5 were males and 2 females. In 5 of 7 cases in which the situation was mentioned the tumor was in the left kidney and in 2 in the right.

In the cases described in the literature the microscopic structure has consisted of either large cavernous sinuses lined with endothelium or thick walled vessels more or less dilated and filled with blood. Thrombosis has been observed within these vascular channels and in several instances deposits of calcium salts. Surrounding the vascular channels there may be round cell infiltration and deposits of pigment.

A distinction must be made between true angioma and other blood containing tumors which may occur in the kidney. Carcinoma in which the spaces and cavities have become packed with blood cells (Fig. 2) is most likely to lead to confusion. Such a tumor may be distinguished by the type of epithelium lining the blood filled spaces and a close examination of different portions of the tumor will usually disclose areas in which hemorrhage has not occurred. Hemorrhagic cysts of the kidney will not be confused with angiomata if one remembers that angiomata are practically always small while hemorrhagic cysts are usually quite large. As shown in a previous paper these cysts usually represent an occluded aneurism and consist of a single cavity while angiomata are composed of multiple cavities. Begg reported a case in which he found angiomatous tissue in the periphery of a hemorrhagic cyst which he believed was responsible for

formation of the cyst. Trauma may result in the escape of blood within the interstitial spaces of the kidney but obviously here again the microscopic picture serves to distinguish this extravasation from angioma.

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PYLORO-DUODENOSTOMY FOR DUODENAL ULCER¹

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In presenting a new operation for peptic ulcer of the stomach or duodenum one must keep in mind that all lesions in these areas which require surgical therapy depend more upon the operation of gastrojejunostomy than upon any other operative procedure and that without this operation surgery of the stomach would never have occupied the useful position that it does today. In those instances wherein the anastomosis does not function properly it can be undone a situation which can never arise with more radical forms of unsuccessful gastric surgery. When there is a more or less complete and permanent obstruction in the stomach or duodenum gastrojejunostomy thereafter drains all of the gastric contents. When an ulcer is present without complete obstruction the greater portion of the gastric contents soon after the operation passes back through normal channels via the pylorus and duodenum. Under these conditions the spastic obstruction in the ulcerated area is relieved and held inactive by the anastomosis which prevents an accumulation in the stomach of gastric secretions sufficient to produce an irritation with its resultant spasm in the ulcer area.

For the successful functioning of this operation the essentials are a proper indication and a proper technique which will bring about a complete drainage of the proximal loop and sufficient drainage of the stomach. The greatest barriers are reflex disturbances of the gastric segment and incomplete drainage of the proximal loop and stomach contents. When a gastrojejunostomy is properly performed upon a patient troubled with a stomach syndrome resembling that of a gastric or duodenal ulcer but due to a gastric reflex the anastomosis merely adds to the distress of the patient. However it is not the peptic ulcer with or without organic obstruction which makes this operation successful. Its success depends in the presence of a proper technique upon an absence of reflex gastric spasms and a postoperative anatomical position of the anastomosis wherein the jejunal loops are completely and the stomach sufficiently drained. Gastrojejunostomies should produce no more distress in persons with perfectly normal stomachs and duodenum than in those with peptic ulcers with or without organic obstructions. It seems rational therefore to assume that the primary pathological condition has nothing

to do with the functioning of this operation because it functions as well remotely after the operation when the stomach or duodenum has been restored to normal or as near normal as possible.

There is a small percentage of patients in whom the most popular gastrojejunostomy in the hands of many surgeons will not function without distress perhaps because of an unavoidable postoperative position of the anastomosis which interferes with proximal loop drainage. Balfour and Moynihan will state that with the enormous number of gastrojejunostomies performed there are found to be a small number unsuccessful which gives undue publicity to this one of the most useful of all surgical procedures. It is an operation which has destroyed or removed nothing having merely added a new function which cannot as with all forms of therapy be expected to be successful to a degree approximating a percentage of 100.

The number of patients in whom a gastrojejunostomy will not function satisfactorily because of insufficient drainage of the stomach and jejunal loops is large enough however to demand attention. There are few operations which leave the average surgeon with more anxiety relative to immediate and remote postoperative obstruction owing to the fact that the postoperative position and condition of the anastomosis and the amount of obstructive peritoneal adhesions surrounding it can not always be foreseen. This inability to obtain perfectly successful gastrojejunostomies in all patients together with the occasional secondary gastrojejunal ulcer has led to the adoption of numerous modifications and new surgical procedures.

The operation I am describing here is brought forth with the idea that it is not a substitute in the majority of instances for the properly indicated and properly performed gastrojejunostomy for duodenal ulcer. I feel that it has a place following an undoing of an unsuccessful gastrojejunostomy and also in some instances wherein it may function satisfactorily without the help of a gastrojejunostomy. Another qualification is that it simulates the normal more than an other operation as yet proposed and if it is successful it can be helped by the addition of a gastrojejunostomy.

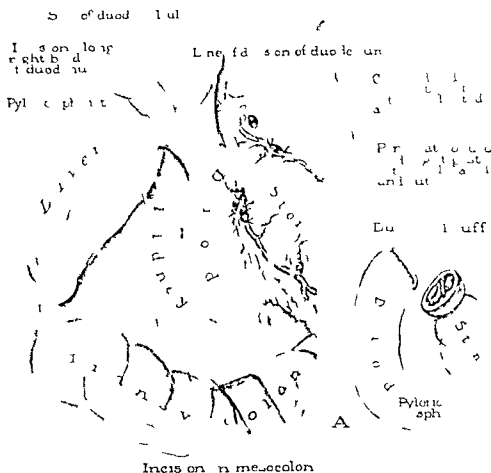


FIG. 1

TECHNIQUE

Six years ago shortly before Haberer¹ described his anastomosis of the resected stomach to the duodenum I began performing the operation herein described. The essential difference between Haberer's operation and mine is that he applies his operation after resection of the distal end of the stomach for gastric ulcers. I apply my operation for ulcers of the duodenum leaving the distal end of the stomach including the pyloric sphincter intact. Haberer's operation is an implantation of the amputated stump of the stomach into the second portion of the duodenum while my operation is a reimplantation of the pyloric sphincter into the second portion of the duodenum.

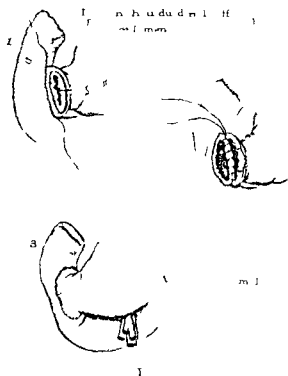
The contra-indications to an attempt to perform this operation are too firm congenital and inflammatory fixations of the descending portion of the duodenum and multiple duodenal ulcers which might prevent a permanent closure of the duodenal stump.

The ideal conditions indicating the performance of this operation are a lack of obesity a

more or less naturally mobile duodenum and a single small duodenal ulcer. The ability of the surgeon as an operator will modify these statements to a certain degree.

Ample mobilization of the duodenum is essential and can be brought about in proper instances by cutting the mesentery of the hepatic flexure and adjacent transverse colon free from the posterior abdominal wall, right kidney and duodenum. This incision is added to Kocher's which is an incision through the peritoneal reflection of the outer border of the descending duodenum. With this combined method and a careful finger dissection the descending and transverse duodenum up to the superior mesenteric vessels can be mobilized to a surprising degree. Care must be exercised not to destroy the blood supply which comes to the duodenum on its concave surface.

After sufficient mobilization is accomplished the duodenum is amputated through its second centimeter from the pyloric ring and the distal opening carefully closed. The ulcer is inverted as the walls of the duodenum are sewed in and without doubt is destroyed by the resultant healing process brought about by the inverting sutures.



The pylorus with its narrow duodenal cuff is then ready for its anastomosis with the second

portion of the duodenum on its peritoneal surface. Experience has taught me that a transverse incision through the pyloric sphincter prevents a too narrow anastomotic lumen as well as a spastic obstruction. This incision should be carried through the duodenal cuff, pyloric sphincter and about 1 or 2 centimeters of the stomach wall.

Most painstaking small but deep latin sutures on a sharply curved needle are necessary for the outer row of the anastomosis in order to prevent too much infolding, and consequent narrowing of the inner orifice. Traction on the anastomosis may be prevented by attaching the falciform ligament of the liver well up on the first half of the stomach after the method which is used by W. J. Mayo.

RESULTS

I have 5 patients now in excellent health and their operations were performed 6, 4, 2, 1 and 1 years ago. I have not restudied any of these recurrences with the roentgen ray and gastric analysis because of the difficulty of having the patient return for examination, but letters from them state that they are perfectly well. This small series of patients indicates that this operation has possibilities.

GASTRO-ÆSOPHAGEAL CARCINOMA ITS DIAGNOSIS

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MALIGNANT lesions of the cardia and of the stomach fundus frequently offer great difficulties in diagnosis. This is particularly true of early cases that is before the onset of marked loss of weight, anæmia and cachexia. Unfortunately this triad of symptoms is considered by many physicians absolutely essential for the positive diagnosis of malignancy, a view in a large measure fostered by the unnecessary prominence given these signs in textbooks. Malignancy of the cardia and of the lower œsophagus is so relatively benign and metastases occur so late that successful surgical treatment may be possible provided diagnosis is made sufficiently early.

It is the purpose of this paper to report a survey of the methods used by various clinicians and roentgenologists in establishing early diagnosis, to attempt to estimate the relative value of clinical symptoms (objective and subjective) generally considered of cardinal importance and to report two cases which gave rise to considerable difficulty in diagnosis.

RELATIVE INCIDENCE

In an attempt to determine the relative incidence of carcinoma of the cardia it was found that it is included indiscriminately in the statistics dealing with carcinoma of the stomach and with carcinoma of the œsophagus. Greater precision in this respect is most desirable.

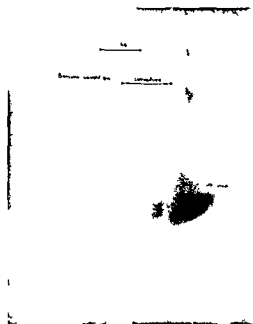
Carcinoma of the fundus and of the cardia is of relatively frequent occurrence. In a series of 50 cases of primary carcinoma of the stomach in the autopsy records of the Peter Bent Brigham Hospital reported by Duggan (5) 8 per cent occurred at the fundus and 12 per cent at the cardia, that is, in 20 per cent of this series the growth was located in the region of the gastro-œsophageal junction. Spriggs (22) reports 5 cases of gastric carcinoma of which 16 per cent occurred at the cardia. In Welch's analysis of 1,300 cases of malignancy of the stomach, 104 (8 per cent) were situated at the cardia and 19 (1½ per cent) at the fundus (12). In Walton's series (25) of 150 cases of gastric carcinoma, 60 (40 per cent) occurred at the cardiac end. In Taylor and Miller's series (23) of 182 cases of gastric malignancy, in 10 per cent of the cases the tumor growth began at the fundus or cardia. Of 551

cases of carcinoma of the stomach operated on at the Mayo Clinic (1918-1920) reported by Hartman (7) 39 (7 per cent) were found to be at the cardia. Walton (25) quotes Meyer to the effect that carcinoma of the cardia forms 50 per cent of all cases of carcinoma of the œsophagus. Vinson (24) reports 154 cases of œsophageal cancer of which 62 (40 per cent) began at the cardia and secondarily involved the lower œsophagus. Lihenthal (14) states that malignant tumors of the œsophagus are most frequent at the cardia.

SYMPTOMS

The symptom complex of carcinoma of the lower œsophagus of the cardia or of the fundus is not in each case a clear cut entity, varying with the situation of the lesion, but is very similar in all three situations. Nor is it sharply distinct from the picture presented by such conditions as cardiospasm, spasm of the œsophagus, carcinoma of other parts of the stomach, etc. It is only by very careful investigation of all cases complaining of suggestive symptoms and a thorough understanding of the difficulties in examination due to the anatomical situation of the lesion and of the pitfalls arising from the limitations of the various methods of diagnosis at our disposal that the number of undiagnosed cases will be reduced to a minimum.

The symptoms of carcinoma of the fundus are very often referred to the œsophagus (Palugay, 17) while symptoms of cancer of the cardia are generally gastric in nature (Walton's Surgical Dyspepsias). Frequently carcinoma beginning at the fundus gives rise to symptoms which point to the œsophagus as the offending organ and the associated spasm of some portion of the terminal œsophagus leads, even after careful but incomplete examination, to a diagnosis of cardiospasm or spasm of the œsophagus. On the other hand the symptoms may suggest a gastric origin and a ray examination of the stomach may reveal an irregularity of the duodenal cap which in this case is only an expression of the increased irritability of the stomach. In this manner only the associated condition is disclosed and the true disease is overlooked and allowed to go on until cachexia and marked loss of weight make the diagnosis more obvious. One must bear in mind the possibility of a gastric carcinoma in the



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presence of œsophageal symptoms which may be present early and are usually present in advanced cases

MODE OF ONSET

Albu (1) states that in every case of gastric carcinoma there is a symptomless latent period of



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several months duration and that the initial stage at which the patient becomes aware of the disturbance may be considered the second stage of the disease. Especially is this true of carcinoma of the fundus corpus and of the lesser curvature. Friedenwald (6) divides gastric carcinoma into two groups according to the manner of onset. The onset of symptoms is sudden in a large proportion of cases and is gradual in a



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smaller number in which the cancer has developed from a pre existing ulcer. In his series of 1000 cases of gastric cancer a history of previous digestive trouble was present in only 23 per cent of his patients while the onset was sudden and acute in 77 per cent. Deaver (4) also describes two similar clinical types of gastric cancer one with history of long duration beginning with ulcer symptoms which later change to those of carcinoma and a second group in which the onset is insidious with vague symptoms of indigestion and epigastric distress and is rapidly progressive. Walton (25) maintains that the onset of symptoms of cancer at the cardia is nearly always insidious and the symptoms are generally gastric in nature.

The symptoms of which the patients usually first become aware are inconstant indefinite and often transitory occasionally they are permanent.

Loss of appetite partial or complete is a fairly constant symptom. It was present in 89 per cent of the cases in Friedenwald's series. In 5 cases of cancer of the cardia fundus and lesser curvature near the cardia reported by Soule (21) loss of appetite was present in 4 cases.

Gas eructation is a prominent and early symptom in carcinoma of the cardia (Albu 111 Spriggs 22). Albu also mentions as early symptoms bitter taste in the mouth regurgitation of small quantities of food or sour liquid a sense of tension in the stomach and rapid satiation.

Dislike of certain articles of food particularly meat is a common symptom. This may at first be inconstant. Nausea is occasionally present.

Dull pain is occasionally present but as indicated severe pain is frequently only a comparatively late symptom. It is usually drawing in character and radiates from the stomach in various directions especially to the back and shoulders. It occurs independently of meals and may vary in the same patient. Albu believes the pain to be due to the drawing of the serosa into the tumor mass or to adhesions with neighboring organs. In Friedenwald's series pain was present in 93.1 per cent of the cases and as an early symptom in 84 per cent. In carcinoma of the cardia the discomfort or pain may be felt to the right of the epigastrium behind the sternum or in the back (Spriggs). The pain in the epigastrium may go through to the back. It comes on shortly after or even during every meal and is persistent. It differs from pain occurring in carcinoma limited to the oesophagus in that it is present after meals and is not caused by the passage of food through the oesophagus. Very severe pain usually indicates a relatively wide

spread growth and adhesions to the surrounding structures (Walton).

Vomiting is a constant symptom only in cancer of the pyloric region. Regurgitation of actual food is more characteristic of oesophageal cancer.

Hamatemesis occurred in 22.7 per cent of Friedenwald's series.

Dysphagia may be caused by the direct obstructing effect of the growth if situated at the cardia or when malignancy of the fundus has spread to the lower oesophagus or in either case indirectly by the associated spasm which may be present even before the growth is large enough to cause obstruction. At this stage the picture assumes definite characteristics of oesophageal disease. Dysphagia occurring in a patient over 40 years of age is a symptom of grave importance. In 78 per cent of cases in Friedenwald's series difficulty in swallowing appeared early. In two cases reported by Palugay the onset of dysphagia was sudden with remissions of short duration. Both cases were associated with spasm which probably explains the sudden onset and intermittent character. A slowly developing dysphagia progressively becoming worse with remissions occurring only at first if at all should raise a strong suspicion of the presence of malignancy of the oesophagus or the region of the gastro oesophageal junction. An apparent improvement in the condition consisting of a temporary disappearance of the dysphagia in a well developed case should not be misleading. (The degree of dysphagia increases with the progress of the growth until occlusion of the lumen finally occurs. This may be followed by pressure necrosis and disintegration of the central tumor mass with consequent temporary diminution of the dysphagia.) At first occasional dysphagia is brought on by swallowing a large hard and rapidly chewed bolus. Soon even very carefully masticated food is swallowed with difficulty but may be washed down by fluids. Ultimately it becomes impossible to get solids down even with the aid of fluids and finally even fluids cannot pass. There is usually an associated sense of pressure behind the sternum which may be moderate in degree or quite severe. In cancer of the oesophagus it is only very rarely that the onset of dysphagia is sudden and is then probably due to the secondary spasm. In this connection Ridder's observation (20) is of interest. It is very characteristic of carcinoma of the oesophagus that narrowing can be demonstrated earlier subjectively than objectively by means of the sound. When remissions occur they are usually of short duration.

As the case progresses other symptoms may develop regurgitation cough hiccup and choking sensations

Rehfuess (19) quoting Irtatt states that excess salivation is often an early symptom of malignancy of the lower œsophagus Howarth (9) makes a similar observation

Hoarseness and aphonia due to pressure of secondary enlargements upon the recurrent laryngeal nerve are fairly frequent findings Vocal changes occurred in 18 out of 6 cases reported by Siskin (quoted by Silenthal 14)

Walton mentions lack of strength and energy as early symptoms of carcinoma of the cardia

Loss of appetite gas eructation pain and dysphagia are the only frequent and early symptoms Only the last is suggestive of lesion of the œsophagus cardia or fundus

EXAMINATION OF PATIENT

The patient presents a definite picture of malignancy only very late in the disease and it is therefore advisable to omit a description of a so called typical case but rather to discuss the individual signs their relative frequency and importance

Marked malnutrition and cachexia as has already been stated are late manifestation and according to Allu should not constitute an important part in the carcinoma picture In very untypical cachexia is often entirely absent (Wheeler 1) and in carcinoma of the lower œsophagus marked cachexia is rarely seen (Howarth 9)

Fever is comparatively rare in gastric carcinoma It is intermittent in character lasting weeks or months (Allu) In young individuals fever occurs earlier and is more frequent (Wheeler 1)

Enlargement of the supradiaphragmatic gland is a comparatively infrequent finding in malignancy of the stomach and when present indicates marked advance of the disease In 1500 cases reported by Allu such enlargement was present in only 1 Wilton however reports its occurrence in 3 per cent of gastric cancer cases

LABORATORY METHOD

The test meal does not give conclusive evidence for or against the presence of malignancy This is particularly true of carcinoma of the cardia and fundus since gastric retention does not occur in such cases

Achlorhydria does not necessarily indicate malignancy while on the other hand normal acid values in the case of hyperacidity may be present Hornik quoted by Rehfuess states that in 50 per cent of the cases acid is present in the stomach

either in the beginning or constantly Although free hydrochloric acid and later the combined is very often absent in cancer absence of free hydrochloric acid occurs in benign disease of the stomach while its presence does not exclude carcinoma Kuettnner (13) Hurst (10) and others express the same conviction Hartman gives the following figures for 551 cases of gastric carcinoma occurring at the Mayo Clinic during a period of 3 years Ignoring the location of the tumor achlorhydria occurred in 53.72 per cent hypochlorhydria in 15.78 per cent normal values were present in 17.4 per cent and hyperchlorhydria in 4.1 per cent of the cases Normal or hyperacid values were therefore present in 19.5 per cent of all cases in the series while achlorhydria was present in little more than half of the case Hartman's figures for achlorhydria occurring in a case of cancer at the cardiac end are a little higher—54 per cent These figures are based on the higher titrations of tumor and fractional gastric analyses In Ell's series of 50 cases (15) 17 per cent had normal or hyperacid values in the resting juice and the fractional analyses brought the figure up to 50 per cent Taylor and Miller (6) give the following figures for 182 cases of carcinoma Acid termination was done on the 45 minute fraction of the fractional meal Achlorhydria was present in 54 per cent hyperchlorhydria in 4.5 per cent normal acidity in 14.8 per cent and low acidity in 2.2 per cent of the case (Normal in hyperacid values in 13 per cent) In Ell's series of 1000 cases showed a much higher proportion with achlorhydria (53 per cent) He draws attention to the fact however that there is a natural tendency to a diminution of gastric secretion after the fortieth year in which it is not uncommon to find the condition as a manifestation of old age

Here shall not therefore be state between malignancy and this finding as evidence of the presence of malignancy I conclude however that a somewhat frequent finding in carcinoma of the fundus and cardia is not a sufficient constant finding to make it a valuable aid in diagnosis According to Allu however the rule in fundal carcinoma is the absence of free hydrochloric acid In marked contrast with this statement stand the figures of Hartman who found free acid present in 35.46 per cent of 39 cases of cancer at the cardiac end of the stomach

Secondary carcinoma of the stomach frequently presents in an area of the stomach is already a late sign (Allu) It may however be local even in advanced cases Hurst (10) reports cases of 93 per cent and 10 per cent of hemoglobin respectively

In 1 of the 2 cases reported in this paper the blood picture was normal. According to Hirschfeld (8) anemia associated with leucocytosis in the absence of fever or infectious diseases should lead one to suspect malignancy.

Occult blood in the stools is a very constant and early finding. Tarry stools occur much less frequently (in 18.9 per cent of Friedenwald's series). Occasionally occult blood may be temporarily absent from the stool and it is therefore necessary to repeat the test on several occasions.

Thus subjective and objective symptoms as well as laboratory findings are insufficient to establish early diagnosis. Although some of the symptoms enumerated are very frequently present in carcinoma of the region of the gastro-æsoophageal junction their presence does not constitute proof of such a lesion. They should serve however to arouse the suspicions of the clinician and to prompt him to exhaust all method of examination before declaring that a malignant lesion is not present.

According to Chevalier Jackson (11) there are only two reliable methods of diagnosis in carcinoma of the œsophagus: the X-ray and œsophagoscopy. The latter is unfortunately of little value in the diagnosis of cancer of the cardia or fundus even in the presence of extensive invasion.

X-RAY DIAGNOSIS

From the roentgenologic point of view there are two pathological groups of fundus and cardia cancer: (1) infiltrating flat growths associated with shrinking (scirrhous type); (2) the fungating cauliflower type of growth. The medullary type of tumor which in the rest of the stomach gives rise to a filling defect is seen in the fundus as a tumor shadow jutting into the gas bubble which may divide the barium stream as it enters the stomach. This type of tumor growth gives comparatively little difficulty in diagnosis. It is the flat squamous cell type that is troublesome. To diagnose cancer at the cardia we must depend upon irregularity of the cardia and of the terminal portion of the œsophagus as direct signs.

The main difficulties in the X-ray diagnosis of cancer of the fundus and cardia are those caused by (1) the location of the growth. In the case of carcinoma situated at the fundus the lesion may be overlooked (unless it is a medullary one and encroaches upon the gas bubble) because the barium suspension does not fill the fundus in the upright position nor do peristaltic waves or dinarily traverse the upper pole of the stomach. In the ordinary routine positions of examination cancer of the cardia may be overlooked because

the liver shadow hides the subdiaphragmatic portion of the œsophagus (Ridder 5) and in the horizontal position because the last portion of the œsophagus and with it the cardia are covered by the filled fundus (Palugay 16). (2) Carcinoma of the fundus as has been previously stated is frequently associated with spasm of the cardia or lower œsophagus and that of the cardia with spasm of the lower œsophagus. These associated spastic manifestations may mask the more serious condition lower down in the gastro-intestinal tract. It is necessary therefore when ordinary methods fail to resort to special methods of X-ray examination in suspected cases.

If the barium suspension enters the stomach without being arrested in its downward course or without disclosing some irregularity of the areas under inspection the barium paste should be tried. Very careful screen examination in addition to skiagraphy is essential. The patient is examined in the upright left oblique position to begin with. This position brings into view the œsophagus in the greater part of its course. It is essential to have the patient take single small sips of the opaque meal. Very often a large mouthful of barium suspension is arrested at the cardia while a small quantity will trickle into the stomach without any difficulty. The swallowed barium is followed in its passage through the œsophagus particular attention being paid to the manner of its entry into the stomach. There is frequently partial or complete arrest of barium at the cardia and in the case of fungating tumors of the lesser curvature near the cardia a forking of the barium stream or the presence of a tumor shadow silhouetted against the background of the gas bubble may be present. When complete arrest of barium occurs at the lower end of the œsophagus in spite of taking small quantities at a time spasm of the cardia or of the œsophagus is diagnosed. Absence of marked dilation or tortuosity of the œsophagus will tend to rule out true cardiospasm as opposed to spasm of the cardia or of the œsophagus. Smoothness of the contours of the lower end of the barium filled œsophagus does not rule out malignancy since spasm occurring oral to a lesion may be situated in an entirely normal portion of the œsophagus. Palugay (16) quotes Assman to the effect that in idiopathic dilatation the subdiaphragmatic segment of the œsophagus often lies transversely and is directed to the left while in carcinoma it follows an almost vertical direction and there does not occur any greater lateral deviation to the left than that usually present. Howarth (9) and Rehffuss (19) find that the

triangular space formed when the œsophagus turns forward and to the left to enter the diaphragm is often obliterated in malignancy.

If in spite of slow sipping the barium does not enter the stomach and the œsophagus is not found to be markedly dilated or tortuous that is if signs of longstanding obstruction are absent the patient should be re-examined after administration of antispasmodics to the limit of tolerance. In the words of Halguy (17) "It is only when the passage of barium through the cardia occurs that an examination of this region can be made and a decision be made whether spasm only is present or an organic lesion in addition. Only the presence of smooth contours and a normal behavior of the cardia mechanism in the spasm-free stage permits one to exclude carcinoma of the cardia."

Shrinkage of the stomach and its displacement upward and to the left may be present in scarred carcinoma of the stomach (Carman 3). Diminution in size of the stomach in cancer of the cardia is also mentioned by Allen. Both signs were present in one of the cases reported here.

Absence of the gas bubble is an important sign. Infiltration of the cardia may give rise to inefficiency of the cardiac sphincter resulting in escape of the gas normally filling the fundus. Thus a permanently absent gas bubble is evidence of patency of the cardia and points to the possible presence of infiltration (Bergmann 2).

The patient should next be examined in the horizontal position. For proper examination of the fundus it is necessary to have the stomach well filled. Normally the fundus fills the dome of the left diaphragm and lies in close apposition to it. Its upper limit traces a smooth curve. Occasionally this contour is dentate, the appearance probably having the same significance as the dentate appearance of the greater curvature due to contraction of the muscular mass. This irregularity must not be confused with that produced by a local lesion. In such cases the irregularity is not regularly dentate and it does not follow the sweeping arch of the fundus; the transverse diameter of the fundus is much narrower than usual (due to encroachment of the tumor upon the lumen of the stomach); the shrinkage in scarred stomachs.

If careful examination is outlined above followed to reveal the presence of a lesion in the region of the cardia, then a thorough examination of the cardia is not brought into a direct result in junction in ordinary methods of examination. The reasons for this have already been mentioned. The kiddy also it is the Stuart position. The

stomach is filled with gas and the patient fluoroscoped in an oblique position the rays being directed from the right posteriorly and above to the left anteriorly and below. An unobstructed view of the cardia and terminal œsophagus is obtained in this manner. According to Hahn, carcinoma of the cardia can be recognized even in cases showing but little change in the stomach wall but in which the normal cardia mechanism is disturbed. There is a persistent trickling of barium through the cardia and as a rule the outlines of the opaque meal as it passes through the cardia are seen to be irregular and jagged. It is only however the irregularity of the contrast silhouette in the region of the cardia with the patient in the Trendelenburg position that can be considered as direct X-ray evidence. Hahn-Hohlbaum (18) points out that in cancer of the cardia the upper pole of the stomach is an unusually great distance away from the diaphragm.

The first signs of gastric cancer are (1) tumor shadow bulging into gas bubble (2) irregularity of the barium contour as it passes through the cardia (3) splitting of barium stream on entering stomach.

The indirect signs are

(1) Spasm of the œsophagus or cardia (2) distention of the cardia mechanism (3) shrinkage of the stomach (4) shrinkage of the stomach upward and to the left (5) increased distance between the upper part of the stomach and the diaphragm (6) narrowing of the fundus (8) obliteration of the triangular space mentioned by Howarth in the left half.

At 8 o'clock the patient is asked to lie on the left side. The X-ray beam is directed from the right posteriorly and above to the left anteriorly and below. An unobstructed view of the cardia and terminal œsophagus is obtained in this manner. According to Hahn, carcinoma of the cardia can be recognized even in cases showing but little change in the stomach wall but in which the normal cardia mechanism is disturbed. There is a persistent trickling of barium through the cardia and as a rule the outlines of the opaque meal as it passes through the cardia are seen to be irregular and jagged. It is only however the irregularity of the contrast silhouette in the region of the cardia with the patient in the Trendelenburg position that can be considered as direct X-ray evidence. Hahn-Hohlbaum (18) points out that in cancer of the cardia the upper pole of the stomach is an unusually great distance away from the diaphragm.

negative. The pulse was 84 regular with good volume and tension. Systolic blood pressure was 125, diastolic pressure was 80. The heart findings were negative. The abdomen was full and soft. No organs or masses were palpable. There was no tenderness. Lymphatic genito-urinary and nervous systems were negative. Rectal examination was negative except for hemorrhoids. The urine was essentially negative. The stool showed occult blood on several occasions. The blood Wassermann was negative. In the gastric analysis the tube failed to enter the stomach.

Bougies were passed without difficulty down to 45 centimeters from the teeth. No obstruction was met until the cardiac end of the esophagus was reached.

Direct esophago-copy on July 1925 led to a diagnosis of stricture of the esophagus. The pathological report of biopsy specimen taken from the lower end of the esophagus was: There is no definite evidence of inflammatory reaction or of neoplastic proliferation.

Barium examination. The patient was instructed to swallow barium in small sips. There was some delay at the cardia. The esophagus was only slightly wider than normal. The lower end of the column of barium in the esophagus showed a fine irregularity. Barium entered the stomach in a constant, small trickle and was caught in a small irregularity of the gastric wall on the lesser curvature just below the cardia. The retained barium remained there throughout the examination. The stomach was very small and lay entirely to the left of the spinal column. In the horizontal position a small sized filling defect was seen on the lesser curvature near the cardia. This defect corresponded with the area of irregularity observed in the upper portion.

On the grounds of persistent dysphagia without remissions, the presence of blood in the stool and the barium findings diagnosis of carcinoma involving the lesser curvature and esophagus was made. Three months later because of increasing difficulty in taking nourishment and the resulting marked emaciation surgical intervention was decided upon. The operation was performed on August 27, 1925.

It was with difficulty that the dome of the diaphragm was reached. There was a suspicious hardness around the lesser curvature of the stomach and the celiac axis probably in addition from the lower esophageal growth. The fundus of the stomach was firmly fixed.

A Witel gastrostomy was done. A snipping from the lower end of the esophagus was reported as undoubtedly carcinoma, one from the growth of the lesser curvature was too small for diagnosis.

The patient did well for some time then gradually declined and died on November 26, 1925.

CASE 2. M S H white 45 years old was first seen on June 1, 1926. He complained of pain behind the lower end of the sternum on eating, difficulty in swallowing solids accompanied with pain, eructation of gas associated with pain, increased salivation, loss of weight and appetite. His illness began 2 years previously. He first complained of a little pain behind the lower end of the sternum with every meal. Frequently only the first swallow brought on pain and the pain disappeared with the taking of additional food. The pain did not radiate. It was relieved by bicarbonate of soda. There were gas eructations but there was no nausea or vomiting. The condition persisted for about 2 months and was followed by a remission of months. During the subsequent 18 months the patient suffered from recurrent attacks of pain coming with the first swallow and disappearing with the taking of additional food. During the preceding 6 months the pain had increased in severity and was not relieved by food or medicaments. At the time of the examination the patient complained bitterly of the pain behind the sternum which now came through to the back and of painful gas

eructations. Increased salivation was quite marked and a very troublesome feature. The appetite was poor and because of the pain the patient feared to eat. The bowels were sluggish, there was at no time diarrhea or melena. The weight had gone down from 130 to 112 pounds.

The patient had undergone three complete and separate examinations with the following results. In March 1926 a diagnosis of duodenal ulcer was made. He was put on Sippy diet. He was better for 2 weeks with a subsequent return of the symptoms. In April 1926 an examination was entirely negative for organic disease. A diagnosis of gastric neurosis was made. In May 1926 a diagnosis of pyloritis of the lower esophagus was made.

Personal history. The patient has suffered from asthma and constipation for 20 years. Asthma was cured 2 years ago. With these exceptions he has always been well. The family history revealed nothing of interest.

Physical examination. The patient showed signs of marked loss of weight but he was not cachectic. The pupils were dilated slightly to light and accommodation. He had several capped and carious teeth. There was a moderate degree of pyorrhea. The tongue was coated. The pulse was 80 regular with fair volume. Systolic blood pressure was 130, diastolic 80. Heart and lungs were negative. The abdomen was flat. There was slight tenderness over the entire abdomen. No masses or organs were palpable. Lymphatic (no enlarged supraclavicular glands), genito-urinary and nervous systems were negative. Rectal examination was negative. In a gastric analysis the fasting content was 10 cubic centimeters. There were no food remnants and no blood. Free hydrochloric acid was 0 total at end of 1 hour 20 total 40.

The urine was negative. Stool was dark brown and formed. Shown a faint trace of occult blood. Blood was negative. Hemoglobin was 90 per cent, red cells 4,900,000, white cells 7,200—a normal blood picture. A small specimen from lower end of esophagus revealed inflammatory cells and a few suspicious cells but no definite evidence of carcinoma.

Barium examination. Barium suspension entered stomach without being delayed at the cardia. Fundus was narrow and rigid. The barium could not be forced into it by pressure from below. A small quantity of barium remained caught and was distributed in an irregular manner in the fundus. The gas bubble was absent but as the patient swallowed a little air was seen in the fundus. This however quickly left the stomach and was belched up. Whenever that happened the patient complained of pain behind the sternum. Peristalsis was active. The cap filled well. The stomach was empty in 6 hours. Examination of colon revealed 72 hour stasis. Diagnosis: infiltrating growth of fundus involving cardia and causing insufficiency.

On July 29, 30 and 31 the patient passed tarry stools. By this time the patient was confined to bed and had lost considerable weight. He was taking very little food because of the pain and was rapidly failing. On August 5 a Witel gastrostomy was done. Operation revealed carcinoma of the fundus involving the cardia and extending posteriorly to the spine and adherent to it. Patient did not stand the operation well and died on August 31, 1926.

CONCLUSIONS

In both cases errors in diagnosis were made several times. A survey of the literature on the subject reveals the fact that such errors are quite common. The apparent reasons for this have already been considered. If it is kept in mind that

lesions of the cardia may give rise to œsophageal and gastric symptoms and lesions of the fundus to œsophageal symptoms much could be accomplished toward diminishing the number of undiagnosed cases or toward making the correct diagnosis earlier.

Carcinoma of the fundus may give rise to œsophageal symptoms only. Such cases are particularly liable to errors in diagnosis since all attention is centered on the œsophagus. Investigation reveals nothing but the presence of œsophageal spasm and the disease is labeled functional. Esophagoscopy may reveal a little irregularity or bulging of the mucosa but a specimen taken even from an advanced case may show no signs of malignancy. The spread of carcinoma is submucous and unless a negative specimen includes a portion of the submucosa no value can be attached to the findings. Lesions of the fundus may by extension involve the œsophagus and those of the œsophagus may in a similar manner involve the fundus. Evidence is not lacking that the cardia does not serve as a barrier to the advance of malignant growths either from the fundus upward or from the œsophagus downward. Furthermore there is anatomical evidence that such extension does occur and is quite frequent.

Malignant disease of the gastro-œsophageal junction is so unlikely to be limited to only one of the three situations under discussion either in actual origin involvement or in the development of symptoms that it appears to be unwise to speak of carcinoma of the fundus of the cardia or of the last portion of the œsophagus. There appear to be sufficient grounds for referring to cancer of these areas as gastro-œsophageal cancer. A further advantage in the use of this term is that it simplifies the problem of classification and incidentally make the literature on the subject more readily available. The use of such nomenclature is sanctioned by precedent—the term ileocecal tuberculosis.

SUMMARY

1. About 15 per cent of all malignant gastric lesions are situated at the fundus or cardia.

There is no definite symptom complex pathognomonic of carcinoma of the fundus or cardia.

3. The tendency of malignant lesions of the cardia and fundus to give rise to gastric and œsophageal symptoms respectively is responsible for many errors in diagnosis.

4. Dysphagia is the most important symptom and may not be directly due to the lesion but to an associated spasm. A slowly developing dysphagia progressively becoming worse with re-

missions occurring early if at all is strong evidence in support of a diagnosis of malignancy.

5. Loss of appetite, gas eructations and pain are the most frequent and early symptoms but they are present in so many other conditions that they acquire only secondary importance.

6. Malnutrition, anemia and loss of weight are late manifestations and their absence does not constitute evidence against malignancy.

7. Enlarged supraclavicular glands are rarely present and if present occur late.

8. Achylia and anemia are not reliable signs but are of secondary importance. If present anemia is a late manifestation.

9. Occult blood in the stool is an almost constant finding.

10. Esophagoscopy is of little or no value as an aid to diagnosis except in carcinoma beginning in the lower œsophagus particularly in the presence of malignant ulceration.

11. The most important method of diagnosis is careful radioscopic and radiographic examination in all positions. The direct and indirect signs are enumerated.

12. The use of the term gastro-œsophageal carcinoma is suggested for malignant lesions involving primarily the terminal œsophagus, cardia or fundus.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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SURGICAL TREATMENT OF THE NEURALGIAS

SINCE Spiller suggested section of the posterior root of the gasserian ganglion in 1899 for the surgical treatment of trigeminal neuralgia no new principle of treatment has been introduced. There have been modifications in technique but only with the purpose of reducing postoperative mortality and morbidity. Experience with section of the larger nerve trunks and avulsion and section of the peripheral nerves has demonstrated how futile such measures are to produce anything but temporary alleviation of symptoms. The injection of alcohol by various methods which afforded temporary relief was a valuable addition to the treatment particularly in early cases and in those in which the physical condition of the patients rendered surgical procedures too hazardous. With the lapse of time however the conception has been confirmed that in order to effect permanent cure the trigeminal nerve must be interrupted between the gasserian ganglion and the brain stem.

When glossopharyngeal neuralgia was recognized and established as a clinical entity

the failure of operations on the nerve trunks to bring about permanent relief led Adson to adopt a procedure analogous to that practiced in trifacial neuralgia namely severing the glossopharyngeal nerve proximal to the superior and petrous ganglia. Although sufficient time has not elapsed to establish evidence of permanent cure the relief following the procedure extending in one instance over 6 months and experience with the analogous procedure in trigeminal neuralgia bespeak success.

Because of the satisfactory results of these operations especially in cases of trigeminal neuralgia section of the posterior root for complaints resembling trifacial neuralgia became inevitable. The argument was advanced that if the face were anesthetic no pain would be felt. In some instances the differential diagnosis was confusing in others there were only slight resemblances to the classical syndrome. Critical study of this group of cases has demonstrated that as a rule the pain is pulling drawing deep seated and constant in character. If paroxysms occur they are infrequent and are likely to be prolonged for hours at a time. The complaints are as a rule bizarre. It has been emphasized repeatedly that trigeminal neuralgia is a disease of unswerving constancy and that variations from the accepted syndrome constitute different forms of disease demanding different methods of treatment. Most of these cases are to be classified with migraine the psychoneuroses the changes incident to senility and entities the nature of which has not yet been determined. It is now commonly agreed that not only is operation in these cases ineffective

but in certain instances it aggravates the condition. Even cervical sympathectomy after previous section of the posterior root of the gasserian ganglion has failed to relieve the patient's complaint.

A group of patients who have received less consideration are those suffering from the disability incident to the pain and paresthesia following herpes ophthalmicus. Adson reported cases in which he cut the posterior root of the gasserian ganglion without success. The explanation that failure resulted because of involvement by the underlying process of structures within the brain stem has recently been corroborated by Lhermitte and Nicolas whose contribution shows that the essential pathological change of herpes may involve simultaneously the ganglion and the central grey matter.

That the application of the principle of section of the posterior root for the relief of other types of pain has not been successful does not detract from the original success of the procedure but merely limits its applicability to one form of human scourge. It has become obvious that section of the respective posterior root is the only curative measure for trigeminal and glossopharyngeal neuralgia and conversely that this type of operation is effective only in cases of true paroxysmal neuralgia.

JOHN B. DOYLE

WHY SURGERY IS INDICATED IN HYPERTHYROIDISM

WITHIN the past two decades our knowledge of the glands of the body, both duct and ductless, has markedly advanced. This is especially true of the thyroid gland. We now associate the pathology of the thyroid with the clinical symptoms of disease of this gland and the clinical symptoms with the metabolic rate. The etiology of goiter is very obscure, there being

four theories regarding it: (1) The earth and water and (2) the toxic infective theories; (3) the theory of the absence of iodine from food and (4) that of multiple causation in relation to general hygiene. Since the cause of goiter is unknown to us, naturally the medical treatment is non-specific. It is true that improvement may result from many different forms of treatment, but it is equally true that improvement often, although cure will follow in a certain small per cent of cases, even though no treatment is instituted. This latter is especially true of cases of hyperplastic goiter. Unfortunately, most of the patients die before the spontaneous cure occurs.

Simple endemic goiters, as well as those of adolescence and pregnancy, should be treated medically. Colloid goiters due to iodine deficiency can usually be cured by the administration of iodine or thyroxin. To the experienced thyroid surgeon they become surgical only in the presence of cyst formation and pressure symptoms.

There is no doubt that the epithelial cells of the thyroid can be altered and even destroyed by the action of the X-rays and thus their function can be modified and even abolished. But according to the belief in formed on this subject, the X-ray is curative in a very small number of cases. Cline, judging his results by means of the respiratory exchange, places the efficacy of radiotherapy between that of simple ligation and that of resection of the gland. One must not forget that the action of the rays is markedly cumulative; that a result apparently favorable at the beginning may eventually turn out to be excessive; that the adhesions after radiotherapy are often more marked than those following surgical intervention; and that when these patients do come to operation, what may have been a comparatively easy surgical procedure is made very difficult.

Surgical treatment offers to the patient suffering from hyperthyroidism either from exophthalmic goiter or toxic adenoma (nodular goiter with hyperthyroidism—Rienhoff) by far the best chance for recovery. A conservative estimate of results after 5 years shows that 60 per cent of the patients are cured, 30 per cent greatly benefitted, 1 per cent improved and 3 per cent unimproved. After the same period a fair estimate of the medical treatment would probably be a reversal of these figures.

These 40 per cent partial or complete failures as you choose are explained by Richter upon the basis of the removal of insufficient gland with resulting residual symptoms and a persisting increased basal metabolic rate. In his own work he reports 93 per cent cures, patients free from any evidence of thyrotoxicosis. Undoubtedly the work of Richter will have a stimulating effect on thyroid surgery and the percentage of definite cures.

The administration of iodine in the form of Lugol's solution as advocated by Plummer as a preoperative procedure in exophthalmic goiter is routine in all goiter clinics. Its effect is so remarkable as to cause it to be considered a specific in the preoperative preparation of exophthalmic goiter patients. It is not to be considered as a curative agent for its effect is transient. When the maximum effect of the drug is obtained that is an artificial remission usually within 10 days as manifested clinically and by the basal metabolic rate your patient is ready for surgery. Surgery should not be delayed as the efficacy of iodine diminishes with each subsequent course.

The use of iodine in the preoperative preparation of patients with toxic adenomata is a debatable question. Plummer still believes

that it should not be used while Graham and Cutler advocate its use. With the large number of cases of iodine hyperthyroidism being reported it may be wise to abstain from its use until more conclusive evidence has been offered in its favor.

Digitalis is useless for the purpose of counteracting the nervous and toxic acceleration of the pulse. Its action is entirely superfluous because the heart is already overstimulated by the hyperthyroid condition, the only effect of the digitalis therefore being a toxic one. Plummer even goes so far as to state that the very definite reduction in mortality at the Mayo Clinic in patients with toxic adenomatous goiters to less than 1 per cent was directly due to stopping the use of digitalis. However, it should always be given in cases of circulatory troubles due to a cardiac lesion.

Our surgical patients are very exacting; they demand to know the risk to have a scar which is scarcely visible; their recurrent nerves and parathyroids must remain uninjured; sufficient thyroid must be left for future requirements; and above all they must be guaranteed against a recurrence. In spite of all these demands the well known goiter clinics of our country show a mortality of less than 1 per cent for all types of goiter. So in speaking of other than surgical treatment for the toxic thyroid we should not compare but should contrast. Until the etiology of goiter is discovered surgery is the method of treatment and the indication for operation is the diagnosis. The case of the surgeon is ably summed up by Richter: "I have not had failures from my thyroidectomies though I have not infrequently failed to accomplish a thyroidectomy in the first attempt."

J. E. STRUTHERS

MASTER SURGEONS OF AMERICA

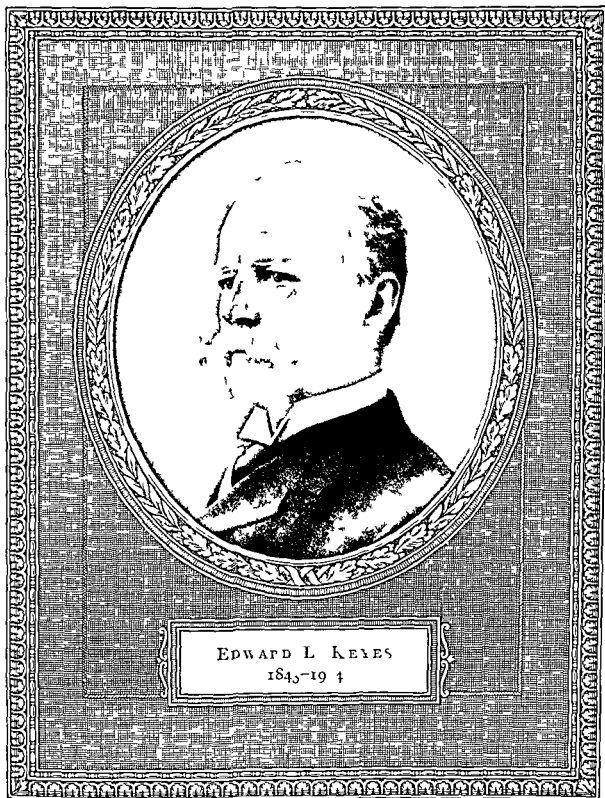
EDWARD LAWRENCE KEYES

MEN stamp their personality upon their time in one of two ways. Some leave the impress of their adventurous and romantic characteristics; they are the discoverer, the inventors, the poets. Far more numerous are those who impress their contemporaries with the very essence of their character: their industry, their intelligence, their honesty, rather than by a definite invention or discovery. Such are the statesmen, the educators, the scientists. The happy combination of the two is rare, yet it was found in Edward L. Keyes, M.D., LL.D., K.S.G.

Dr. Keyes was born August 8, 1841, at Fort Moultrie in Charleston Harbor, South Carolina, of Erasmus Darwin Keyes, who later commanded the Union troops at the battle of Fair Oaks, and was ultimately Major General of Volunteers, U.S.A., and Caroline M. Clarke of Brooklyn, New York. His forebears were Puritan; his education was received at Dedham, Massachusetts, and at Yale (A.B., 1863), where he rowed on the Freshman crew and was a member of the Scroll and Key Society.

After a brief staff captaincy under his father at Washington during the closing months of the Civil War, young Keyes entered New York University Medical College, graduating in the customary years in the spring of 1866. Under the advice of his preceptor, the professor of surgery, William H. Van Buren, he then immediately proceeded to Paris to specialize in dermatology. After a year in Paris, he returned to New York, where he offered himself to Dr. Van Buren as an assistant, only to be informed that Doctors Swift and Gouley already filled all the available space, but that he, Keyes, could do odd jobs if he wished. His acceptance of this humble prospect and his industry thereupon were rewarded when, shortly, the dispute about the invention of the tunneled urethral sound dissolved the association between Van Buren and Gouley, while Swift died, leaving Keyes as first assistant of the town's brilliant and fashionable surgeon.

Curiously enough, in view of his later surgical developments, Keyes' special qualifications as a dermatologist seem to have sidetracked him from that career as general surgeon to which the assistant of the professor at the University and the visiting surgeon to the New York Hospital might well have aspired. We find him holding the first clinic in dermatology in the United States at the



EDWARD L. KEYES

1843-1914

Woman's Medical College in New York in 1870. The next year he was professor of dermatology at Bellevue Hospital Medical College to which he joined the specialties of syphilology and genito urinary surgery thus beginning his surgical career as a specialist with a hospital appointment first at the Charity (now City) Hospital and later at Bellevue Hospital where he established the first ward in the country devoted exclusively to genito urinary diseases.

He continued to teach until 189. His sound logic his gifts of expression his sympathetic personality and his keen sense of dramatic values made him a most effective clinical lecturer. What old student of his will forget the first words of his opening lecture? The Professor enters briskly greets his students in a few words as a patient is being wheeled in on a stretcher then he turns to the patient whips the sheet off the ulcerated malodorous 'Gentlemen this is syphilis!'

We find him in his youth combating the errors of the day proving by experiment that clean urine injected into the peritoneum does not infect that urethral chill does not follow the passage of a sound unless this enters the deep urethra warring with Otis on the latter's theory as to strictures of large calibre attacking successfully the electrolytic treatment of urethral stricture and spreading the whole of his scientific knowledge upon the pages of that classical textbook on genito urinary diseases and syphilis by Van Buren and Keyes of which the first edition appeared in 1874 and which has been a standard textbook of urology from that day.

Doubtless his greatest contribution to scientific medicine was his paper on the clinical effects of small doses of mercury read before the International Congress of Medicine in Philadelphia in the year 1876. At this time current practice regarded syphilis as an evil only one degree worse than mercury. The treatment of the disease consequently consisted chiefly in the administration of iodides and various potent herbs of which the magic formulae persist to this day while here and there an adherent of mercurialization subjected his patients when their disease became unbearable tounctions which were continued until the patient had spat out such teeth as he was willing to lose.

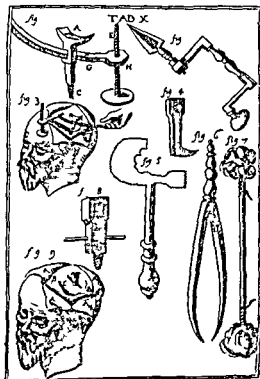
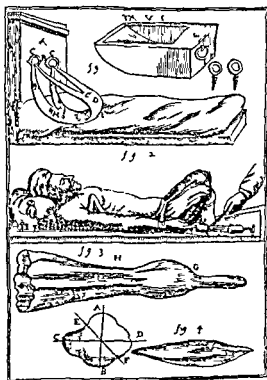
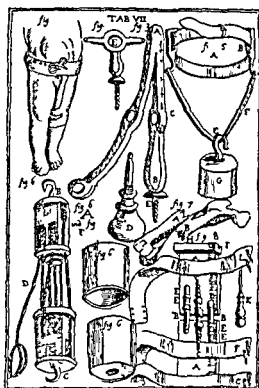
As Keyes used to tell the story it was the insistence of Dr. Piffard before the New York Pathological Society that mercury was totally evil which first set him thinking it might be good. Piffard drove his logic too hard and Keyes went back to his home in Eighth Street wondering whether it was quite as bad as all that. A new hæmocytometer was ordered from Paris. Keyes and his friend Stimson proceeded to dose themselves with mercury and check the results with blood counts syphilitic and non syphilitic patients at the hospital were submitted to a like investigation and it was shortly proved that mercury in small doses is a tonic. Upon this thesis was founded the method of internal administration of the drug advised by Keyes and generally adopted in this country during the last 20 years of the nineteenth century.

In his latter years though he continued always to consider himself a general practitioner (and was once jeered at by his fellows for missing a meeting of the American Association of Genito Urinary Surgeons because of an obstetrical case) his originality manifested itself more in the duly spoken word and in the activities of his pupils Alexander Fuller Chetwood and Keyes Jr. The most notable contributions of these men were probably those of Fuller in originating the treatment and especially the surgery of the seminal vesicle (and incidentally the first crude theory of the metastatic origin of arthritis) and in the establishment of suprapubic prostatectomy upon its modern basis. Of these items the ones relating to the seminal vesicle and rheumatism seem to have belonged wholly to Fuller but the details of prostatectomy as described by Fuller were those of the operation performed by both.

So much for the inventor. The man was bigger. Though no organizer his authorship of an accepted textbook his pellucid honesty his gift of precise speech his kindness to all made him inevitably the founder and first president of the American Association of Genito Urinary Surgeons. Later his gifts in oratory won him the central oration at the opening of the New York Academy of Medicine in Forty Third Street. He served a term as Vice President of the Academy. In the privacy of his office he was the true helper of the sick interested far less in organization progress or individual invention than in solving the puzzle presented by each patient in his turn. Here the simple nobility of his character and his understanding sympathy gave him that hold upon his generation which is the physician's great reward. In his youth he had been isolated a month with Charles O'Connor when the latter returned from Europe with smallpox and years after when the man who smashed the Tweed ring was dying at Nantucket and was told that the family had sent for Keyes he said "Don't let him come this time I want to die."

He himself succumbed to the old man's friend pneumonia at the age of eighty on January 4 1924.

E. L. KILLES



THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

BY ALFRED BROWN M.D. F.A.C.S. OMAHA, NEBRASKA

THE SURGERY OF FABRICIUS HILDANUS

SURGICAL Observations were the fashion in the literature of the late sixteenth and early seventeenth centuries. Clinical Surgical Pathology was coming into its own. For the most part these Observations were rather hit or miss reports of cases—usually unco-ordinated and following no definite schema. Some of them were of considerable value to surgical development, all are interesting to present day readers, peculiar and exaggerated though some of them may be. For in this lies much of their charm. Occasionally a surgeon is found who went beyond the mass of his contemporaries and from his study and experience produced a work of more outstanding merit than the usual Fabricius Hildanus or to give him his full name Wilhelm Fabri Hilden belonged to the group of Master Surgeons of his time and his superiority is so evident that he has been called the German Paré.

He was a barber surgeon but contrary to the rule, he was also a well educated man. He first attended a school at Cologne where he learned Latin and thus fitted himself for the study of the eminent surgical authors. When sixteen he took up the study of medicine under various wound surgeons. Duguesne, Solanus, Solenander who was educated in Italy and Weyer. He probably studied also under Bartsch at Metz. He went to Geneva when he was twenty six years of age and began to practice and the following year married Marie Colinet who was versed in midwifery and helped him in his work. In later years when Fabricius was away on one of his long consultation trips his wife with the assistance of his students cared for his practice. With his advent in Geneva Fabricius' reputation and practice began to grow. Though he never served actively in war he was considered one of the great wound surgeons and his first work of importance was on burns—wherever he went he was in constant search for information and particularly post mortem and anatomical work. Among other activities he articulated a skeleton which he presented to the City Library of Berne to take the place of the one presented by Pierre Franco which had fallen apart.

Constantly moving from city to city he nevertheless found time to write his Observations and his first One Hundred appeared at Basel in 1606. Then followed numerous other work—on gunshot

wounds, war surgery, the necessity for a knowledge of anatomy, lithotomy, four hundred more Observations and other. His work was monumental. In his old age when sixty eight years had taken their toll he felt his powers waning and also experiencing the tortures of the gout he withdrew to a practice just outside the city of Berne. Finally in 1634 he died.

It was not until after Fabricius' death that his work was collected and the most important portions gathered into a single work. The first edition written in Latin and published by J. Beyer at Frankfurt am Main appeared in 1646. It was reprinted many times later and translated both into French and German. The volume illustrated here is the edition of 1679 published at Geneva by Jean Antoine Chouet and translated from Latin into French.

The work has been arranged in the form of the textbook of the day and divided into chapters or books. The first tumors against nature includes also inflammatory conditions and hernia, the second surgical observation of wounds, the third ulcers, fistulas etc., the fourth fractures and dislocations, the fifth the operations of surgery, the sixth general surgical observations and finally an addendum a treatise on gangrene and phagedenic. Following the index and concluding the volume are the illustrations printed from engraved copper plates.

Fabricius Hildanus like his French predecessor Paré was an indefatigable worker, a careful observer of minute clinical detail and a student of morbid as well as normal anatomy. When one seeks for any one great discovery or great advance in surgery to account for the greatness of the man it cannot be found. To be sure he was probably the first to remove a metallic foreign body from the cornea with a magnet and he invented the ear speculum. As an operator he was conservatively daring, not shrinking from amputations of the thigh or the opening of deep abscesses with the cautery and scalpel but these are details important though they may be. Rather his greatness lies in his painstaking methods and attention to detail. His friendships with his contemporaries must also be mentioned. Much of the material for his collected work came from his letters to his friends. One feels that for him his motto *Omnia tutela a Deo* could not have been better chosen.

selected about 400 French 600 German 100 Italian and 1600 Spanish words having bacteriological significance and has given the English equivalents. The words from each language are grouped separately. While no claim is made for completeness of selection yet the more important and usual words have apparently been successfully chosen and intelligently translated. Because of its convenience of size and content the book should prove of value to those who have occasion to read or refer to the bacteriological literature of these several countries.

ALEX LEF A DAY

THIS cleverly assembled little book on a glance in anatomy aims to present some of the recent advances in anatomy as an exhibit for the enlightenment of such as might not be aware that anatomy is advancing. As a missionary tract it should do particularly well in the author's homeland where the sterile blight of traditional anatomy continues and the experimental method as practiced in America remains the monopoly of physiologists. The particular British skeleton is deliberately rattled by the author in the introduction when relating a conversation with a physiologist who told him his task was easy since there are no recent advances in anatomy. One cannot imagine a physiologist on this side of the water talking so—unless indeed he were purblind and gouty.

Nor can one agree with the author's further contention that the recent advances in anatomy are merely typical bits of physiology that anatomists try a hand at. It so happens that the physiologist is commonly concerned with functional activities *per se* whereas your anatomist usually inclines to use physiology as a tool for the explaining of the anatomical pattern at the bottom of it all. An inspection of the table of contents or a casual turning of the pages of the present volume will convince even the casual browser that it records the work of anatomists *sensu stricto* and not of apostates to another science.

The author further confesses that this new outlook is the result of a year's sojourn at Johns Hopkins which exercised a great influence in determining his attitude to the venerable subject of anatomy. A moderately captious critic might remark at this point that the wonder of it all must have rendered him morose as well for many of the topics and the viewpoint adapted reflect the local attitude there even sometimes to the unjust suppression of deprecation of good data so unfortunate as to emanate elsewhere. Lest this stricture appear unjust one may by way of example inquire why the greatest controversy in the history of American anatomy—that of the origin of endothelium now settled at the expense of Hopkins prestige should be omitted from consideration in its proper place?

As a whole the topics comprise an interesting and representative selection although they must remain as samples reflecting the personal interests of an individual. Whereas laymen will find this book too technical and general biologists may be disappointed in the selection of topics those interested in the medical sciences should welcome it as an interesting and significant review—and perhaps of revelation.

The several topics comprise sixteen chapters: Microdissection tissue culture oestrus ovulation and menstruation the youngest human ovum growth centers and organizers the morphogenesis of nerve fibers vital staining the origin of the cells of the blood the cerebrospinal fluid postural organs the cell nucleus the extrapyramidal system the cerebellum the projection of the retina in the central nervous system protopathic and epicritic sensation and X-ray anatomy. There are numerous illustrations brief and all balanced bibliographies and a leguate index.

L B ARRY

THE object of the book *Tonic Hardening of the Colon* is to describe an ailment which the author believes has not been generally recognized by the medical profession. He points out that Sir Charles Sherrington has shown that a muscular fiber may as a result of nervous control become fixed in any condition of extension or contraction and become static. This is in contrast to the ordinary contractile mobile power of muscle.

The author believes that the colon as well as other portions of the gastrointestinal tract may become afflicted with more or less persistent static fixation. This he terms tonic hardening of the colon. Objectively this condition results in a hard palpable colon which is tender to pressure. Subjectively the patient is afflicted with multitudinous symptoms which run the gamut of what are usually considered functional nervous symptoms. The author lists crying spells screaming fits neuralgic pain mental depression labyrinthine vertigo hyperacidity lapse of memory phobias vasomotor symptoms lassitude reflex vomiting as well as pain in the abdomen which occurs after meals on awakening in the morning and coming on after midnight.

The treatment consists of giving liquid hydragric perchlor and liquid fern perchlor as an intestinal antiseptic salol on occasions lactic acid bacilli at other times and in other instances atropine. He advises a diet which eliminates coarse food and vegetable tables rich in cellulose.

In a general way the picture described corresponds to what is ordinarily called spastic colitis with marked neurotic manifestations.

The author's views are advanced with keen enthusiasm in the subject. It is not a book for Missions.

A C DAVID

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FIFTEENTH ANNUAL CLINICAL CONGRESS IN BOSTON

UNDER the leadership of a strong and representative committee of Boston clinicians a program of clinics and demonstrations in the hospitals and medical schools of that great medical center is being arranged for the eighteenth annual Clinical Congress of the American College of Surgeons during the second week of October from Monday, October 5th to Friday, October 9th inclusive. All departments of surgery—general surgery, gynecology, obstetrics, orthopedics, urology and surgery of the eye, ear, nose, throat and mouth—will be represented in this program which will include clinics and demonstrations at the following institutions: Harvard University, Boston University and Tufts College medical schools and the following hospitals: Beth Israel, Boston City, Boston Dispensary, Boston Lying-in, Peter Bent Brigham, F. I. Oberlin, Cambridge, Currier Children, Deaconess, Faulkner Free Hospital for Women, Huntington Memorial, Long, and Massachusetts Eye and Ear Infirmary, Massachusetts General, Massachusetts Homeopathic, New England Bygones, New England Hospital for Women and Children and St. Elizabeth's.

The morning of Monday, October 5th will be devoted to the annual hospital conference which will be continued on Tuesday and Wednesday. Operative clinics and demonstrations in the hospitals and medical schools are scheduled for

Monday afternoon and for both morning and afternoon of each of the three following days. A preliminary clinical program is to be published in an early issue of SURGERY, GYNECOLOGY AND OBSTETRICS.

At previous sessions a series of evening meetings is planned and the programs thereof are now being prepared by the Executive Committee of the Congress and will be published in the journal at an early date. These will include a number of highly interesting papers on various surgical subjects of present-day interest presented by eminent surgeons of the United States, Canada and Great Britain. At the Presidential Meeting on Monday evening to be held in Symphony Hall the President-elect, Dr. Franklin H. Martin will be inaugurated. Another feature of that evening's program will be the John B. Murphy Oration in Surgery. The meetings on Tuesday, Wednesday and Thursday evenings will be held in the grand ballroom of the Copley Plaza Hotel. On Friday morning the annual Convocation will be held in Symphony Hall.

Since the last session of the Clinical Congress in Boston in October, 1922 a number of new hotels have been built including the Statler with 1,000 guest rooms. Several of the older hotels have been rebuilt or enlarged so that there are now fully the first-class hotel accommodations in Boston for all who will attend.

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EIGHTEENTH ANNUAL CLINICAL CONGRESS IN BOSTON

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FIFTY-NINTH ANNUAL CLINICAL CONGRESS IN BOSTON

UNDER the leadership of a strong and representative committee of Boston clinicians a program of clinics and demonstrations in the hospitals and medical school of that great medical center is being arranged for the eighteenth annual Clinical Congress of the American College of Surgeons during the second week of October from Monday, October 5th to Friday, the 9th inclusive. All departments of surgery—general surgery, gynecology, obstetrics, orthopedics, urology and surgery of the eye, ear, nose, throat and mouth will be represented in this program which will include clinics and demonstrations at the following institutions: Harvard University, Boston University, in the Tufts College medical school and the following hospitals: Beth Israel, Boston City, Boston Dispensary, Boston Lying-in, Fetter Bent, Bellevue, Fetter Brigham, Cambridge, Carver, Children, Dana, Faulkner, Free Hospital for Women, Huntington Memorial, Long, and Massachusetts Eye and Ear Infirmary, Massachusetts General, Massachusetts Homeopathic, New England, Byrd, New England Hospital for Women and Children and St. Elizabeth's.

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SURGERY, GYNECOLOGY AND OBSTETRICS

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SURGERY OF THE PANCREAS

WITH SPECIAL CONSIDERATION OF ACUTE PANCREATIC NECROSIS¹

By PROF. DR. V. SCHMILDEN and DR. W. SEBENINC, FRANKFURT A. M., GERMANY

511 University of Frankfurt

A QUARTER of a century ago in a lecture before the Congress of American Physicians and Surgeons on "The Present Status of Pancreatic Surgery with Especial Emphasis upon Injuries and Inflammation," the famous German surgeon von Mikulicz designated pancreatic surgery as the least complete chapter in abdominal surgery. Even today there are numerous unsolved questions in practical as well as scientific pancreatic surgery. Why do so many people die from this acute dread disease? Is the question that has troubled the surgeon for the past half century. This is especially true since Balzer in 1883 published a description of fat necrosis. Gusenbauer was the first to record a case of pancreatic surgery, his report being made in 1885. Since Halsted in 1898 described an operative procedure for the cure of acute pancreatitis and Koerte in the same year set forth his very comprehensive and fundamental work which seemed to cover all of the then current knowledge of pancreatic disturbances, very little of note has been published on the subject.

However, experimental research on the pathogenesis of pancreatic surgery has added a noteworthy chapter to the unfinished history. This experimental research aided by surgical autopsies has led to a complete understanding of the devastating effect of the pan-

creatic enzyme when placed extraneously and to an understanding of the too early activation of the digesting enzyme in the gland itself coupled with autodigestion of the pancreas.

As a result of clinical observation and experimental research there have been developed in the past 30 years systematic operative principles which have brought about successful results in pancreatic surgery. There has been no sudden marked progress which can be compared to the solution by the internist of his most serious pancreatic problem, namely, the treatment of diabetes through the use of insulin. Because of the physiological and pathological nature of the pancreas this branch of surgery has developed slowly and even now it does not seem likely that more rapid progress will be soon forthcoming.

As hypothetical theories are gradually replaced by established facts, the surgeon will approach the practical solution of the clinical problem and will eventually evolve an ideal treatment and possibly adequate prophylactic measures.

Our opinion upon the present status of pancreatic surgery is based not only upon our own experiences and the reports in the literature but upon a study of 2137 cases which have been treated in the past 8 years. Questionnaires were sent to over a hundred clinics and hospitals and a general report on the answers

¹ Condensed report made by Prof. V. Schmilden before the Society of German Physicians in 1927, with bill to law and tables in the Arch. f. klin. Chir. vol. 119. Translated by Prof. J. F. Lyon, M.D., Chicago.

was presented by von Schmieden at the Society of German Surgeons in 1927. It is impossible to give here a complete review of all of the information obtained so we will limit our discussion to the subject of pancreatic necrosis.

The anatomicopathological picture (Fig. 1 frontispiece) shows simultaneous necrosis in inflammation and hemorrhage. In a discussion as to which of the two plays the primary role Opies and Guleke are of the opinion that necrosis is the dominating factor. This opinion has come to be the generally accepted one. The earliest studies naturally show the unmixed picture. But from this one cannot conclude that the all important pancreatic drama may not be secondary to a primary inflammation—pancreatitis—with necrosis and hemorrhage secondary or that hemorrhage as a result of syphilis or arteriosclerosis (pancreatic apoplexy) may be a primary pathological change. Hemorrhage is followed by necrosis and inflammation due to invasion of the pancreatic enzyme which immediately become activated. The explanation of both Bergmann and Guleke is of utmost importance in understanding the pathogenesis of this process. They believe that the symptomatology and course of the disease is secondary to an intoxication from the autolytic destruction of the pancreas. The trypsin itself is not the direct causative factor but it is a protein formed by the pancreatic autolysis. It is rapidly absorbed and death results in a few hours before resistance is developed either by an inflammatory process or by antitoxin.

The change in the pancreas vary tremendously in type and degree. Early alterations consist of edema often bile stained with a serous infiltration of the entire body of the pancreas. There may still be however a complete recovery without damage to the parenchyma (Zoepffel). In an advanced stage the gland resembles variegated marble in color because of the diffuse swelling and hemorrhagic infiltration (Fig. frontispiece). A result of further destruction there develop structures necrotic tissue macrophages in color from brown to dull gray so that ultimately the gland assumes a cooked

appearance. In the presence of excessive hemorrhage there may be a complete disappearance of the tissue structure and the pancreas is changed to a blue red blood clot. The typical disseminated spots chalky and opaque of fat necrosis may appear within 16 hours. These spots together with the peritoneal effusion give the surgeon a diagnosis pointing to the pancreas as the causative organ. Langerhans, Hildebrand and Flexner believe that the enzymic action rather than the bacterial action is the cause for the splitting of the fats the changing of the neutral fat to sodium and calcium soaps. These are found in the gland itself in the peripancratic fat and scattered throughout the entire peritoneal cavity as well as the retroperitoneal subpleural mediastinal pericardial and even subcutaneous tissues they have even been described symmetrically scattered about in the extremities (Jenkel).

The blood stream is the only accepted means by which the enzyme which splits the fat in the typical distant place is spread (Lippinger, Payer and Martin). In the peritoneal cavity the reaction is due to direct contact with the enzyme and most frequently the toxin is conducted by the lymphatics to other areas. Istock working in Guleke's clinic has recently demonstrated this by new and important evidence.

Should the pathology be arrived there still is the further danger from the extension of the process to the peritoneum (peritonitis toxica) and further to the retroperitoneum and eventually it is possible even to the pleura (Clurmont). In these locations the peritoneal exudate containing the enzyme acts in its usual manner and lead to tissue destruction a primary sterile inflammation with a secondary bacterial infection the original bloody exudate becoming purulent. As a result the glialular parenchyma being poor in connective tissue rapidly disintegrate giving off pancreatic sequestra which subsequently drain out in masses together with the operative discharge. The organs may become swollen to the size of a man's fist and the patient is endangered by still other complications. In the prolonged subacute type of the disease there may be a

downward seeping of the pus and if the patient survives the intoxication and peritonitis he is still liable to suffer from a pyemia with or without mesenteric thrombosis or else he may suffer from an involvement of the portal veins.

The normal protective tissue reaction is everywhere decreased by the corrosive action of the gland secretion. There may occur perforation of such viscera as the stomach or the bowel ruptures in the neighboring body cavities or severe even fatal hemorrhage of the numerous blood vessels surrounding the gland. Occasionally a case may develop a pancreatic pseudocystic disintegration cavity which should be recognized as part of the healing process.

In spite of the fact that the methods of pathogenic development are numerous the etiological causes will be found to be even more frequent. Neither experimental results nor clinical observations have solved the problem of prophylaxis from an etiological aspect. We present here only those experimental results which in dogs either through mechanical or toxic tissue damage or by blood vessel and tissue changes have produced the homologue to the human clinical picture. The initiating factor for the development of the morbid process has however not yet been demonstrated in a manner free from all possible criticism. We do know that the lymph channels and blood vessels are the most important paths through which the most destructive agents flow (Fig. 3).

There have been clinical observations of all these etiological possibilities. Duodenal diverticulitis is one of the least recognized factors in acute pancreatic necrosis but its genesis has been forcibly established by the work of Forssell and Key, Case, Wilkie, Åkerlund and Clairmont.

Of greater significance are the variations in the pancreatic ducts and their mouths. Osler explained these variations in the relations by the embryological development of the gland and Clairmont differentiates ten major types. By means of iodine injections in the tail of the pancreas in cadaver preparations we have been able to demonstrate even more anomalies of the duct system.

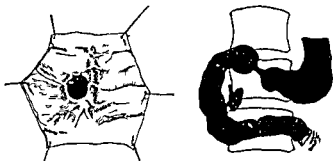
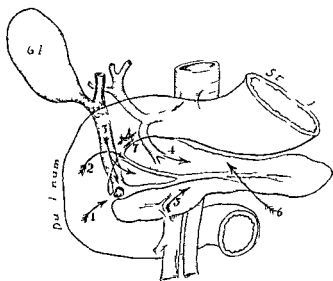
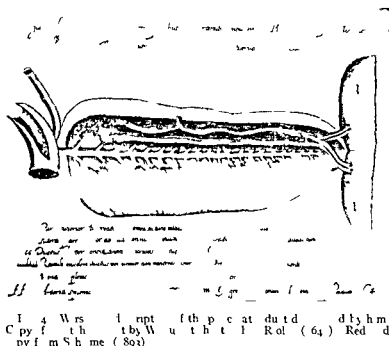


Fig. 3. Schematic description of the anomalies of development of pancreatic ducts and the duct of Wirsung from the duodenum. The duct of Santorini from the biliary ducts, 4 from the arteries, 5 from retrograde emboli through the veins, 6 traumatic, 7 from duodenal ulcers through the lymphatics, 8, 9, 10 (lower left) Duodenal diverticula near the papilla, 11 (lower right) Roentgen demonstration of diverticulum by Åkerlund.

Opie was the first to find at autopsy a small gall stone fixed in the ampulla of Vater and it was he who explained the development of acute pancreatic necrosis as secondary to the back flow of bile into the pancreatic ducts. Since then the topographical course of the ductus choledochus and the duct of Wirsung together with their different types of union have been given the utmost consideration (Mayo, Kobson, Osler, Bunker, etc.).

The results of research concerned with the examination of the conditions in which bile can invade the pancreatic ducts are extremely contradictory. While Mann and Giordano found it anatomically possible for a gall stone to block the papilla in such a manner that bile may invade the pancreatic ducts



in 35 per cent of the cases. Judd found it to be true in 45 per cent of the cases and likewise Cameron and Nobel in 66 cases in 100 examined. Our investigation demonstrated that in 8 of 35 cases it was possible after clamping the papilla of Vater to fill the tail of the pancreas from the bile ducts or vice versa.

Our clinical observations are of particular value inasmuch as 7 cases of papillary stones were found among 31 cases of acute pancreatic necrosis with an associated cholelithiasis (Fig. 5).

The recognition of the extreme significance of disease of the biliary ducts in the etiology of acute pancreatic necrosis is not only of marked importance in understanding the pathogenesis but also for diagnosis, therapy and prophylaxis.

While it has been customary to look upon the simultaneous presence of cholelithiasis and pancreatic necrosis as coincidental, it is noteworthy that this combination is more frequently found when the surgeon looks especially for this possibility. This is definitely demonstrated by a comparison of the figures collected from our questionnaire with those of Guleke. There were 894, 69.8 per cent cases of biliary duct disease in 1,264 cases of pancreatic necrosis operated upon whereas

Guleke's questionnaire in 1924 comprising 457 cases had 68 or 59 per cent of simultaneous cholelithiasis (Fig. 6). The percentage of fixed choledochus or papillary stones in the Guleke statistics was surprisingly small while in our report there were 174 common duct stones and 57 papillary stones. Our own material in which the role of the biliary passages was especially noted shows 31 cases of biliary stone in 38 cases (81 per cent) and of the 15 were common duct stones, 7 of which were in the papilla.

In what fashion then does the diseased gall bladder injure the pancreas? The clearest cases are those in which acute pancreatic necrosis results from the fixation of a stone in the ampulla of Vater. The same mechanical damage occurs here as in the experimental production of acute pancreatic necrosis. Stasis of the secretion and elevation of the pressure in the pancreatic ducts together with chemical trauma from the bile and bacteria are the provocative factors. The passage of concretions with their temporary fixation of the ampulla of Vater may act in the same manner. At the time of operation the stone may be found in the bowel (Jung, Zoepfel, Reich). It may not even be found at autopsy so that definite proof of its existence may be

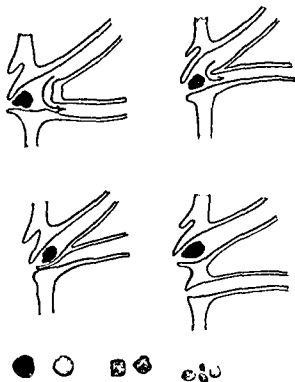


Fig. 5 Obstructive stones in the papilla of Vater and the various types of mouths of ductus choledochus and pancreatic ducts. Below are the stones which have caused the acute pancreatic necrosis contrasted with pepper berries.

lacking. On the other hand the stone may fall back into the dilated common duct after being temporarily fixed at the ampulla. Then there is still the possibility that the successful passage of a stone through the papilla may stretch it and cause it to gape so that the duodenal content may invade the duct of Wirsung and activate the pancreatic enzyme. Stones which are situated in the supraduodenal part of the common duct can have no direct mechanical effect upon the pancreatic ducts but may induce spasm of the sphincter of Oddi so that regurgitation of bile into the pancreatic ducts results. A diseased gall bladder—a cholecystitis—may produce the same effect even though the common duct is free from stones. Obstruction of the common duct above the papilla may cause bacteria and an exudate containing bile from the intrahepatic biliary ducts to invade the adjacent pancreatic tissue and may give rise to an associated pancreatitis. Finally invasion of the lymph glands in the head of the pancreas from the lymphatics of the gall bladder may

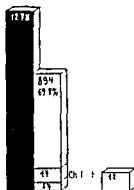
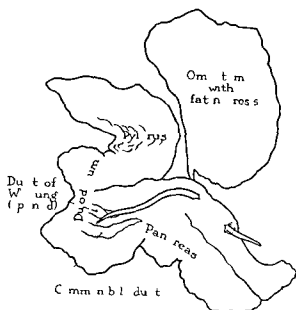


Fig. 6 The overwhelming significance of biliary duct diseases as contrasted with all other etiological factors in the cases of acute pancreatic necrosis operated upon in our collected statistics.

lead to stasis and activation of the pancreatic enzyme.

In occasional cases it is often difficult to demonstrate the genetic connection between cholelithiasis and pancreatic necrosis but its tremendously greater frequency as contrasted with all other known etiological factors justifies the assumption of pancreatic necrosis as a complication of cholelithiasis. Early operations for cholelithiasis are therefore amply justified (prophylaxis). As a rule pancreatic necrosis follows a neglected chronic cholelithiasis (important for diagnosis) but this grave disease can occur early without any evidence of a common duct complication (acute pancreatic necrosis following labor in a primipara). In our youngest patient 13 years old the unmistakable etiological factor was a stone about the size of a pepper berry in the papilla.

Undoubtedly a minute examination of the biliary ducts is a definite prerequisite in every case of pancreatic necrosis operated upon. The correct methods of treatment have been established as far as the treatment of gall stone disease demands. The purpose of this part of the operation must therefore be to conduct the bile away in the quickest and simplest manner and to drain the pancreatic ducts. Rapid gall bladder drainage will suffice if the large bile ducts are free from stones. If the condition of the patient will permit we agree with Nordmann, von Haberer and Zopfer that the operation of choice is cholecystectomy with choledochotomy. Cholecystectomy alone is unsatisfactory.



It is not only hinder drainage but in cases the pressure in the biliary duct system. Internal biliary duct anastomosis (choledocho-duodenostomy) must be condemned because the peritoneum in the neighborhood of the pancreas has poor adhering qualities and at this point all intestinal sutures are unreliable. Moreover such operation take too much time. The statistics in our large series demonstrate the favorable result from the different biliary operation performed and invalidate the conclusion of Cegner who advised against any intervention upon the

biliary passage fearing the resulting disadvantages (Table I). A study of the literature shows that 50 cases of invasion of the duct of Wirsung by ascariade had results similar to those in cases with stone incarcerated in the papilla (Eberle, Finner, Gallie and Brown, Lichtig, Sabrie, Seyfarth). In this connection I wish to report briefly a very rare case of acute pancreatic necrosis due to invasion of the pancreatic duct by ascariades.

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TABLE I—OPERATION PERFORMED IN CASES OF ACUTE PANCREATIC NECROSIS IN WHICH THE BILIARY IRRIGATION WAS DONE AT THE SAME TIME

	R	I	I
	1	1	1
Cholecystectomy	6	44	4
Cholecystectomy and biliary irrigation	4	36	4
Cholecystectomy and biliary irrigation and pancreatic resection	4	38	7
Cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection	4	9	3
Cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection and jejunum interposition	4	4	6
Cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection and jejunum interposition and ileocecal resection	4	4	80

TABLE II—PANCREATIC DISEASE AFTER OPERATION ON THE BILIARY SYSTEM

After cholecystectomy	4
After cholecystectomy and biliary irrigation	3
After cholecystectomy and biliary irrigation and pancreatic resection	3
After cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection	3
After cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection and jejunum interposition	3
After cholecystectomy and biliary irrigation and pancreatic resection and duodenal resection and jejunum interposition and ileocecal resection	3
Total	38

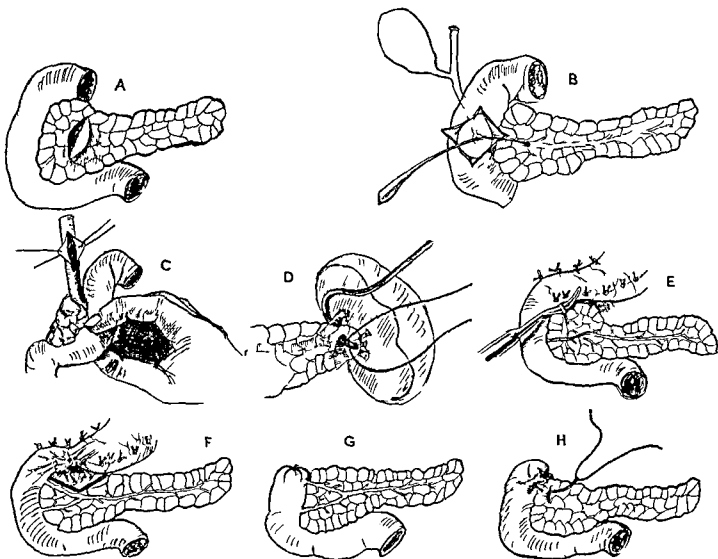


FIG. 8. Operative measures which can lead to acute pancreatic necrosis. A Diagnostic incision from pancreatic substance. B Shifting of sound toward the left and into the pancreatic duct in transduodenal choledochotomy. C The Kirschner maneuver for pushing up gravel or stones with injury to the tail of the pancreas during traction of the pyloric vessel. D Tracing of the duct of

Santorini during separation of the duodenum. E Sharp incision of a penetrating ulcer from the pancreatic substance. F Deep incision of the duodenal stump. G Covering of the duodenal stump with the pancreatic head. H The sutures are too deep and therefore invade the pancreatic substance.

typical hemorrhagic exudate was present in the free peritoneal cavity but there were no stones in the biliary ducts. Death occurred 14 hours after the operation. The autopsy was done immediately and revealed extensive fat necrosis in the omentum and mesentery which had not been seen during the operation. Hemorrhagic infiltration of the entire pancreas with tiny microscopic areas of necrosis. A single ascaris was found in the duct of Wirsung its head reaching to the tail of the pancreas and its tail protruding 1 centimeter into the lumen of the common duct. It was still alive and mobile when the ducts were opened. There were no other worms in the entire gastrointestinal tract.

Next to stasis of secretion and its activation the tissue damage secondary to the

violent penetration by the worm was an important factor in the production of acute pancreatic necrosis. This case is an example of its traumatic genesis and the extremely varied forms of postoperative pancreatic necrosis.

There is no doubt today that an operative trauma which injures tissues should receive great attention. We will later point out a large number of measures such as *alta artis* which have been considered harmless but which we would advise the careful surgeon to avoid. The pancreas should always be considered a labile organ which can be readily injured at operation.

with pancreatic trauma. Fifteen per cent of all cases of duodenal resection develop serous pleurisy which however disappears in 3 to 4 days. It is unfair to assume that all these operations were poorly done. Many surgeons adopt every precaution but one generally accepted warning must be mentioned here namely a reference to a generally rare but grave danger.

When the pancreas has been involved in the operation it is certainly not advisable to close the peritoneal cavity without drainage. This measure affords at least some measure of protection.

Stomach and duodenal operations supply quite a different group of pancreatic complications (Clairmont Table IV) peritonitis may follow suture line leakage which is secondary to the digestion of the technically perfect sutures by the pancreatic enzyme which arises from an unrecognized injury to the pancreatic veins. The mobilization of the duodenum supplies the source of blunt trauma which injures the parenchyma of the pancreas. Excision of the ulcer and faulty handling of the duodenal stump have already been mentioned.

Partial resection of the gland may be done for advanced cancer of the pancreas. This was recommended by Insterer contrary to the existent knowledge of the high incidence of pancreatic necrosis and peritonitis. Von Mikulicz figured that this operation elevated the mortality from 27 to 70 per cent but to day the danger does not appear so great. Because of the same high mortality associated with pancreatic resection for other causes progress seems to be at a halt in this field of surgery.

Anomalies of the ducts supply a separate chapter. It is frequently possible without any danger to mobilize the duodenum and separate it from the pancreas as far as the ampulla of Vater. This procedure becomes hazardous when there is a possibility of impinging upon the duct of Santorini and its ligation is of importance. This was demonstrated by the work which Enderlen suggested to von Schwarz. This research demonstrated upon an embryological basis two forms of pancreas namely a tongue and a hammer type the lat-

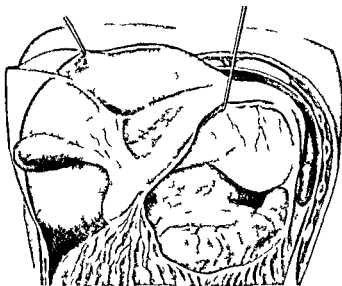


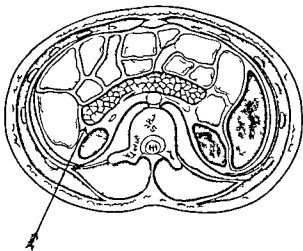
Fig. 12 Transperitoneal exposure of the pancreas through cutting of the gastrocolic ligament

ter usually associated with a large and actively functioning duct of Santorini.

In spite of this the duct of Wirsung may be of importance and there is a definite danger of its being ligated in cases requiring extensive separation. The following conclusions are justifiable from Schwarz's research. There is great danger of ligating the duct and obstructing its drainage in one fourth of all cases in which the pars duodeni is freed. A large duct of Santorini draining an important part of the gland should be feared when the pancreas is firmly fixed to the duodenum or the head of the pancreas is very large (occasionally reaching to the pylorus) the tongue shaped type of pancreas is generally associated with less danger.

These possibilities should be considered and avoided in every pyloric resection which approaches the pancreas. Regurgitation into the duodenal loop should also be avoided because of the danger of associated regurgitation into the pancreatic ducts. In addition care should be taken to keep the duodenal stump which has been inverted into the retroperitoneal space after a Billroth II from pressing too firmly upon the unprotected pancreas.

This chapter still contains many important unanswered questions for the practical surgeon. There is a possibility that the real cause of danger is not yet understood despite consideration of the separate role played by

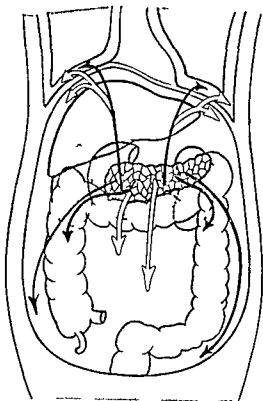


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each type of anatomical anomaly together with the diminution of danger involved in surgical procedure. We may call this a predisposition to pancreatitis a condition readily understood when we consider that in certain cases a biopsy will lead to fatal complications while in other cases there will be an uneventful convalescence.

Culek's experiments have demonstrated that there is marked significance in the phase of secretion but that there is still a predisposition to pancreatic involvement or perhaps a constitutional predisposition such as exists in the alcoholic idiopie or luetic. Perhaps we are right when we consider the sudden onset of this condition as the cumulative effect of all the etiological danger factors. It must be our goal to give this line of etiological reasoning our intensive study.

A consideration of the etiological factor which may damage the pancreas because of an imperfect blood supply indicates that they may include nutrition of the gland due to impaired circulation secondary to passive thrombosis, embolism, arteriosclerosis or to lue. Isotoperative pancreatic necrosis secondary to retrograde emboli belongs in this category (Jenckel Orthner) and may follow any operation in the peritoneal cavity occurring either without manipulation of the pancreas (resection of bowel,omentum or ovary) or when the operative field is distant from the pancreas (proctectomy or operation for vari-



1 3 1 ft 1 1 mb 1 1 1 th 1 1

cose veins). It may follow intoxication through the blood stream either in case of severe poisoning from lysol, oxalic acid meat or strychnine poison or as frequently happens after septic process such as puerperal sepsis, typhus, measles, osteomyelitis or parotitis. Here again we are impressed with the fact that only certain individuals of an entire group who are affected with the same diathesis actually develop this complication. We know no causative factors for its development and moreover we do not know why after the introduction of the same septic process in several individuals one patient will develop an acute pancreatic necrosis with its stormy course and another will develop a purulent pancreatitis which behaves as might a pyemic abscess were it located elsewhere. The relation of the individual and development of immunity together with the local and bacterial conditions naturally have a definite consideration in the prognosis (Zocפל Brutt)

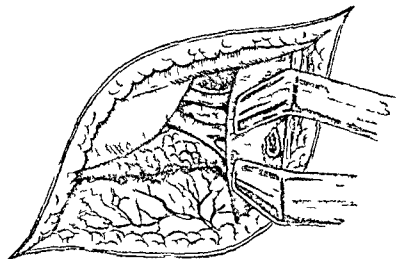


Fig. 15 Exposure of the pancreas through a left lumbar incision and median transection of the kidney. The spleen is visible on the left border of the incision. The splenic artery and vein cross the pancreas which is posterior.

The chapter on bacteriology is purposely slighted because at present it is not possible to evaluate the significance of infection in the development of acute pancreatic necrosis. The material here analyzed was compiled from a questionnaire and did not consist of consecutive cases so that no basis for positive conclusions was afforded (Table V).

Our own findings are based upon 10 cases. Bile from the gall bladder and common duct and the peritoneal exudate was found sterile in 9 cases. Streptococci were found in the bile and the peritoneal cavity in 1 case but may have been due to a secondary infection inasmuch as they were found 10 days after the onset of the disease.

We will only mention the frequently discussed symptoms and satisfy ourselves with a classified grouping of the clinical manifestations. Pain of the most excruciating type is nearly always present and is an important symptom. After very mild colic-like prodromal pains (warnings which may be absent) an apoplectic attack of pain and collapse suddenly develop. These may be the result of intoxication from the pancreatic enzyme which lies free in the peritoneal cavity, the distention of the gland capsule, infiltration of the mesocolon or pressure upon the celiac plexus or upon the semilunar ganglion

(celiac neuralgia). The persistence of the pain until shock develops differentiates it from biliary colic. The pain diffuses backward from the left abdominal region to the lumbar region radiating to the left shoulder. The pulse is at first slow and small and later as a result of vagus irritation becomes still slower. Abdominal rigidity and distention are early signs but there is even at this time little distention and rigidity as contrasted to that occurring in ileus or peritonitis. The temperature is normal or subnormal, there is agonizing belching and vomiting while occasionally the pancreas can be palpated as a transverse ridge (Koerte).

Recognition of the disease at this stage requires a previous suspicion of the diagnosis. The observant general practitioner will recognize cases of peritonitis without temperature or abdominal rigidity. The following symptoms are certainly suggestive: cyanosis of the face, hands and extremities or as described by Walzel, blotches and lattice-like streaks of dark cyanotic color, upper abdominal distention, tachycardia 100 to 140, slight icterus, persistent emesis, absence of bowel movements or flatus, glycosuria and fatty stool. Melena and emesis are rare symptoms as are oliguria and anuria which indicate kidney damage. Systemic intoxication causing

TABLE V.—BACTERIOLOGICAL FINDINGS IN ACUTE PANCREATIC NECROSIS RESULTS IN TWO HUNDRED AND EIGHTY TWO EXAMINATIONS

		C		C sc	
St	l	84	St	l	4
B	t	3	B	t	54
B	ll	4	B	ll	1
St	hyt	34	St	hyt	
St	lt	37	St	pt	d
I	k l s		m	l f t	t
I	ll				
I	typh	11			
ll	lm	1			
f	t				

cramp and psychic disturbances have been observed. Death results from cardiac failure and the symptom complex of paralytic ileus clouds all earlier abdominal symptoms.

In contrast to the rarer general picture there is still lacking a modern aid for making the exact diagnosis in the numerous atypical cases. Even today we must manage without a pathognomonic test which would make the diagnosis positive and which Koerte longed for in 1911. Wohlgemuth's diastase test in which the ferment is easily demonstrated in the urine and blood is of some value. It should be critically considered even when carefully done for even then the failure run about 50 per cent (Table VI).

In most instances one should rely upon the most probable diagnosis and differentiate between gall bladder perforation stomach and duodenal perforation gangrenous appendicitis peritonitis of unknown etiology ileus mesenteric thrombosis and ureteral colic. Our compiled statistics show that a positive diagnosis of acute pancreatic necrosis was made in only 18 per cent (Fig. 9) of the cases and suspected in 17.5 per cent. Therefore the pancreas was considered only in little less than 40 per cent of the cases.

The most common source of error in our series was acute cholecystitis which occurred in 95 per cent. This is readily understood as the patient early in the disease creates the impression of this diagnosis by giving a history of repeated miliary transient attacks from which he completely recovered. On the other hand this is a fatal diagnosis for the physician becomes satisfied with the diagnosis

TABLE VI.—DIASTASE RESULTS IN THE URINE IN NINETY SEVEN CASES OF ACUTE PANCREATIC NECROSIS AS DETERMINED BY TWENTY ONE DIFFERENT EXAMINEES*

		C		C sc	
I	l	78	I	l	9
N	m	1	N	m	1

of gall stone orders morphine and resorts to surgical intervention only when the pain is found to persist and the patient's condition is much worse. The influence of the biliary history together with the existing icterus and absence of temperature causes further delay in those cases in which there are no marked signs of peritoneal irritation. When the condition becomes advanced a preoperative diagnosis of phlegmonous cholecystitis or perforation of the gall bladder is first made and then the patient is prepared for operation.

Even today we do not give enough attention to Koerte's old warning to consider acute pancreatic necrosis in all cases developing acute abdominal diseases especially when biliary colic has been evidenced. The recognition of the close genetic connection between cholelithiasis and pancreatic necrosis is bound to cause the general practitioner to suspect inflammation of the pancreas especially in the presence of an unusually severe protracted colic in which the pain radiates toward the left and one dose of morphine does not give relief. A gall bladder history should afford the possibility of an early diagnosis.

Today the surgeon sees acute pancreatic necrosis quite frequently. Thirty-eight cases were operated upon in the last 8 years and in the same time there were 6 cases of gastric perforation—nearly twice as many. In 1905 Mikulicz reported 75 cases collected from the literature. In 1911 Koerte collected 103 cases. In 1914 Guleke reported a compilation of 437 cases. Our questionnaire which was limited to postwar cases afforded 1,510 cases. The statistics together with the multicausal solution of many individual problems afford a reliable perspective of the position which is held at the present time by pancreatic surgery.

TABLE VII—THE OPERATIVELY DETERMINED DEGREE OF PANCREATIC PATHOLOGY AND THE CURLS FOR THE VARIOUS STAGES¹

		C	ed	P	D ed
		P	t	p	t
9	(Edema without fat necro	7	3	3	
33 4	(Edema with fat necro	6	5	60	1
23 1	Hemorrhia ic infant	36	1	1	0
19 3	Necrosi and areas of oftenm _e	32	0	68	0
3 4	Seque tration	43	1	13	0
7 6	Absce s formation	39	9	3	
	Avera es	48	8		
The facu es	th f t col m g h pe	x	f	<	f h
respect	tag h h ram t p e t				

There is a considerable increase in the number of cases occurring each year. This is especially noteworthy when compared with the well known observation by Wilms of a decrease during the years of the war. We do not believe that this increased frequency is secondary either to overeating, alcoholism or other predisposing etiological factors but we believe that it is due to the modern viewpoint of operating upon all acute abdominal conditions as early as possible. Our statistics show a marked preponderance of 197 plethoric individuals in contrast with 115 of an asthenic type.

The heretofore generally accepted opinion that males are commonly affected is in no way substantiated by our statistics (Fig. 11) which show 980 women and 520 men. This preponderance is readily explained by the greater incidence of cholelithiasis in women.

That this disease may occur at any age was demonstrated by the fact that in our series there were 10 children. Of significance was the coincidental presence of biliary disease in 4 of the 10 cases. Stones were found in 3 young girls 10, 13 and 15 years old and there was a brucillus coli infection in a 6 year old girl. Unfortunately the other cases gave no etiological factor.

Of the 150 cases 178 were operated upon. There were 232 cases not operated upon in 149 cases the patients were already moribund and in 8, cases recovery was spontaneous because of the mildness of the condition. Only those cases in which operation definitely established the diagnosis should be discussed here. Because of the fundamental nature and course of the disease the diagnosis must al

TABLE VIII — COMPLICATIONS FOLLOWING ACUTE PANCREATIC NECROSIS

	C
Diabetes (3 leathis n coma)	18
Chronic pancreatitis	6
Recurrence (6 o urrin within months after operation)	6
With associated treatment of the biliary ducts	7
With treatment of pancrea only	19
Leop ration (to cu d 7 d d)	17
Cyst formation	4
Persistent fistula	5
Adhesion	3

was rem un doubtful in the cases not oper
ated upon

On the other hand there is no doubt that occasional cases of acute pancreatic necrosis may heal spontaneously when the process is favorable and the changes limited. Such cases of spontaneous healing are repeatedly reported in the literature. We ourselves have unexpectedly found residual evidence of pancreatic necrosis in 3 cases operated upon for cholelithiasis. These findings consisted of encapsulated areas of non irritating fat necrosis located in the mesentery and omentum and on the pancreas. Despite the fact that the acute stages of the intoxication may be survived by conservative treatment there occur such complications as areas of softening pseudocyst formation or burrowing of pus which generally necessitate surgical intervention at a latter period.

INDICATIONS AND BEST TIME FOR OPERATION

The question of the indications and best time for operation is comparatively easy to answer inasmuch as every classic case is operated upon as soon as possible. However it is possible neither to predetermine nor to establish therapeutically which case will be severe. The advice derived from experience is to operate upon all doubtful cases. The fact that a patient may have successfully recovered from numerous similar prodromal attacks is not a contra indication to operation. Our experience has shown that cases without premonitory symptoms are the most grave. The firmly established fact that 95 per cent of the cases not operated upon die is sufficient indication of the gravity of the prognosis. Furthermore it is not possible to judge the

TABLE IX—CHRONIC PANCREATITIS IN THREE HUNDRED AND EIGHT CASES

S	l t m	C	73	Spl t t	f t l	C
(l) l k p				t m		7
J l			7	St m h p t		5
D t l t	t		6	I p l t y l p		
(l)			3	I p l t my		
D l l t				R l t		
J y d				C d		39
B l l t l		8		Im j	3	33
D l l l				St l l l		
C t t		4		D d		9
A t l	t		3	C m p l t		
S	l p l			D t h f m t		
I l y t t d				I t		3
B l y l t		9		I t t t l		
t m				P t y t		
Spl t t	f t l		6			
t j l						

severity of the disease from the clinical picture before operating

It is likewise impossible to say how the case which are treated expectantly will terminate. It is possible that a case which is very mild in the beginning may later become very severe. Thus the most opportune time for operative cure has been lost. It is needless to say that in a much later course of the disease is indefinite delay always entails great risk.

We believe that even shock should not be considered a contra indication. Koerte and Culek have already insisted upon the wisdom of early operation from conclusions afforded by their experience and statistical material. We wish again to emphasize strongly the urgency for early operative intervention.

We have previously demonstrated that the operative result depends upon the amount of pancreatic involvement. Undoubtedly the best prognosis is to be expected in those cases in which the pancreatic necrosis is still in the early edematous stage. With necrosis and regional liquefaction the mortality reaches its crest only to decline again with the stage of liquefaction and abscess formation. Our statistics however still further demonstrate that unfortunately up to now only a very small percentage of all cases come to operation in the time favorable for recovery (Table VII).

The most opportune time to operate is when the disease is just beginning. Operative interference is always indicated in those cases

TABLE X—PANCREATIC CYSTS

I t l y	C	A t m	Ca.
T m	6	h l l d d	th
p t		A t m	th
d	8	J J l l	p
N t k n	73	P t	d o e t
I m		k t h p	
Op		I l t	
Ol t t	d by	C d	
t		D d	5
I t p t		Imp l	
Spl t t k	I t m	I	3
I p	5	D b t	3
I t l t p t	3		

in which abdominal symptoms develop suddenly and lead to collapse. Let us however consider how many patients must be operated upon without an exact diagnosis and how many in and very out many people must die while the timid doctor temporizes believing he must wait for a classic clinical picture.

In what manner should we handle the suspected or definitely diagnosed acute pancreatic necrosis? A few preparations should be made to combat the collapse and under a general anesthetic the abdomen should be opened through a large median epigastric incision. All other preparations are made to facilitate rapid termination of the operation.

The goal of ideal surgery in a case of acute pancreatic necrosis is:

1. To demonstrate the pancreatic changes by freeing the pancreas until it is visible.
2. To protect against preid and absorption of the toxic tissue exudate (tissue fluid).
3. To obtain limitation of the process by freeing and draining away the exudate.
4. To provide drainage to the exterior of further profuse secretion and prevent retention and downward infiltration.
5. To remove the primary cause.

The following intraperitoneal method of approach to the pancreas are at our disposal: (1) Through the gastroduodenal ligament between the stomach and the transverse colon and then through (2) the lesser omental cavity—the best method (3) through the hepatoduodenal ligament between the liver and stomach—in moderate intestinal ptosis (3) through the transverse mesocolon after separation of the mesenteric leave—danger of damaging the arteria colica media (4) through the retroperitoneum by separating the omentum

TABLE VI—PANCREATIC STONES IN TWENTY CASES

Symptoms	Cases	Operative removal (all cured)	Cases
Clinical			
Jaundice	3	Found at autopsy	5
Colic	3	Chances of the procedure	
Ulcer	6	Cystic	4
Diabetes		Sclerotic	0
X-ray		Acute necrotic	1
Stone shadow		Carcinomatous	1
Extragastric tumor	1	Fatty	
Stomach cancer	1		

tum from the transverse colon (Stein) and (3) by Kocher's method of mobilizing the duodenum for unusual exposure of the head of the pancreas.

Koerte is also familiar with the left sided approach from the lumbar region (Fig. 13) to the tail of the pancreas and the right sided lumbar approach to the head of the pancreas and finally the transpleural way through the dome of the diaphragm.

It is generally the rule that only the most experienced can give a prognosis even from the condition of the exposed organ. Cases having a limited local reaction are the most favorable. Exposing the gland is insufficient. Surgical interference must be radical.

The peritoneal covering and the pancreatic capsule always should be split as far as possible. In this way the retropancreatic space is made accessible to drainage. The swollen organ is palpated for induration areas of necrosis and finally for stones. It is advisable at this point to incise the gland substance avoiding injury to the ducts. Large areas of liquefaction necrosis are best opened bluntly by the finger. The majority of authors do not believe that axiomatic splitting of the capsule is advisable in every case. Tamponing will frequently stop the bleeding from blood vessel erosions but this complication makes the prognosis less favorable. Hemostatic suture ligatures are in general to be avoided because here one operates in chemically eroded tissue.

The greatest care should be used in walling off the pancreas from the neighboring structures and in establishing drainage. The tampon and drains must be placed so that they do not favor retention of secondary secretion and can be left in from 6 to 8 days.

TABLE VII—PANCREATIC INJURIES TOTAL OF SIXTY TWO CASES—THIRTY CURED THIRTY TWO DIED

	Cases
Blunt trauma	31
(unhot injury)	6
Stat wounds	
Injuries to the pancreas alone	4 cured 6 died
Transverse rupture	4 died 3 died with
in 4 hrs after injury	operated upon and
died 10 days after operation	14
(unhot injury) (urel died)	3
Pressure injury (r l)	2
Fracturation (d d)	1
Complete disruption of injury (cured 6 died)	4
Organ injury at the same time	
Stomach	19
l r	13
Spleen	7
Bowel	8
Kidney	
Urtia	1
Vascular	1
Chilled	1
Chemical	1
Diphtheria	1
Lun	1

The regional fat necrosis is undisturbed. The peritoneal exudate which may be either serous or purulent should be handled as in any other case of peritonitis. It should be removed from every part of the peritoneal cavity either by sponging or by irrigation thus eliminating one source of toxic absorption.

Finally it is necessary to guard against the characteristic downward seepage of pus which is associated with the pancreatic pathology (Fig. 14). Occasionally in the primary operation it is necessary to provide counter drainage in the lumbar region. From our own experience we know that such drainage is easily instituted in the first operation. It often becomes very difficult in the later stages of postoperative handling because of the extensive adhesions one becomes uncertain and fears meeting the retroperitoneal and other vessels. This becomes self evident when the anatomy involved in left sided exposure is considered (Fig. 13). When there is a well walled off abscess in the advanced stages of this disease it is possible to consider only the lumbar method as primary.

A decision as to the operation of choice is most difficult to make and it is of vital importance that the entire surgical procedure be suitable to the patient's resistance.

We have already mentioned the proper procedure when there is associated biliary duct pathology. The biliary operation is done last just before the abdomen is closed and here again emphasis is placed upon a minute examination of the biliary ducts in every case. The reverse also holds true and in every operation for cholelithiasis the pancreas also should be minutely examined.

The cases of acute cholecystitis which we have operated upon usually have circumscribed peripancreatic edema limited to the head of the pancreas. This must be carefully looked for because it represents the first stage of an invasive process from the gall bladder as there is as yet no fat necrosis or serous exudate. The indicated therapy upon the biliary system causes the disappearance of the findings together with those described and brought to our attention by Zopf. Ample drainage and tamponade in the threatening area should be supplied. In this connection we are reminded of a case in which typical fat necrosis was found without any pancreatic changes. This without doubt was a case of spontaneous healing of pancreatic necrosis which had occurred in the previous few months.

However even though the peritoneal cavity be opened it is possible to overlook a case of acute pancreatic necrosis especially in exploratory laparotomies for doubtful acute abdominal diseases. In such case it is always necessary to think of the pancreas and to expose it as the fat necrosis may still be absent and the typical exudate be limited to the lesser omental sac. Another source of error in diagnosis which may cause the overlooking of acute pancreatic necrosis may be in assuming the incarceration of an associated hernia. The pain and the increased bulging of the hernia secondary to elevated intra abdominal pressure suggest incarceration. However the hemorrhagic exudate is believed to be hernial fluid, the distended loops of bowel supporting the false diagnosis and primarily hiding the pathology.

What do we achieve by the surgical handling of acute pancreatic necrosis? Guleke's questionnaire in 1924 indicated a mortality of 52 per cent which is only slightly better than

the 60 per cent mortality reported by Koerte in 1911. We have reviewed 178 cases with a mortality of 65.4 or 51.2 per cent. This result is amazing! We had hoped that the mere result would be much better in a large new series of cases studied at a time when urgent intervention would be more efficient and when particular stress laid was being placed upon early operation. The figure of Table VII explains this very limited improvement.

The figures definitely demonstrate that an actual improvement can be achieved only when operation is performed in the stage before necrosis is present in a fully developed form. In this light we appreciate the idea of early operation and achieve its execution through organization of diagnosis. It is of prime importance that the general practitioner co-operate and at the proper time refer to the surgeon those cases in which there is the slightest suspicion of a beginning pancreatic necrosis.

The hope of receiving some aid from an immunizing agent has unfortunately not materialized. The well known experimental work of von Bergmann and Guleke and that more recently by the Japanese Ohno has been of no help (Harms).

Also there is slight prospect of securing an effective prophylactic immunizing agent in those cases in which there is great danger that the disease will develop.

As yet we are almost helpless in the case which have already developed a systemic intoxication. In our clinic for many years we have used intravenous injection of glucose with insulin. We believe that it may favorably combat the intoxication and recommend its use not only pre-operatively but also post-operatively for the first few days.

There are many serious dangers which still threaten the lives of the patients who survive the operation. Postoperative hemorrhage has already been mentioned. These are rarely stopped successfully by tamponade and usually result fatally late abscess formation and downward seepage of pus together with their course and treatment have already been mentioned. Finally there may occur empyema or numerous septic complications such as parotitis, pyelophlebitis or liver abscesses.

The incision should be kept wide open for many weeks because of the persistent wound and pancreatic enzyme secretion and also because of the extremely long time required for the discharge of the gland sequestra. A temporary pancreatic fistula will naturally result with marked digestion of the tissue around the wound. It usually heals spontaneously after a varying interval of some times weeks or even months.

After the surgical wound treatment comes the selection of a diet which is low in fats and carbohydrates. In this manner due consideration is given to the impaired function of the pancreas which is spared every possible overtaxation.

What later course have those patients who pass through this severe disease? As yet we have no systematic postoperative histories from a large number of cases covering a protracted period. The late results of only occasional cases are available. From the results of the material operated upon in the Frankfurt Clinic and from the literature we may conclude that the majority of cases which are successfully operated upon remain permanently cured. The health and life of a few patients can of course be endangered by the sequelae which may follow an acute pancreatic necrosis. These may be diabetes, chronic pancreatitis, recurrence, cyst formation, pancreatic fistula and adhesions (Table VIII). As yet we are merely listing the results and the essential features of the surgical interference derived from our questionnaire in chronic

pancreatitis (Table IX), pancreatic cysts (Table X), pancreatic stones (Table XI), injuries (Table XII).

CONCLUSIONS

1. Acute pancreatic necrosis is a disease of high mortality with varied pathogenesis and etiology. In the etiology diseases of the biliary tract are of the greatest significance. The genetic connection between bile duct diseases and acute pancreatic necrosis affords special consideration regarding diagnosis, therapy and prophylaxis.

The pancreas should be considered as an organ extremely susceptible to operative trauma and should be guarded against any possible damage especially during the course of operations upon the gall bladder, stomach and spleen.

3. A present day mortality of 51 per cent was found in our compiled statistics in 178 cases during the last 8 years.

4. Only in early operations is it possible to achieve the best results in acute pancreatic necrosis.

5. Systematic postoperative examinations of the patients who have been operated upon for acute pancreatic necrosis are necessary because of the large number of complications which may develop.

6. The results derived from the surgical treatment of chronic pancreatitis, pancreatic stones, pancreatic cysts and pancreatic injuries justify the hope for further progress in pancreatic surgery.

UTEROSALPINGOGRAPHY

FURTHER STUDIES ON THE ACTION OF THE TUBAL SPHINCTER A NEW SYRINGE FOR TRANS-
UTERINE INJECTIONS AND A REPORT OF THE THERAPEUTIC USE OF IODIZED OILS
WITHIN THE UTERUS AND FALLOPIAN TUBES

PA JULIUS JAI CHO MD FACS NE YORK

A J C et al d m Sy J h m H l c J A J C () I H I H p I H I H I D h

f b h m C l c f g h () I H I H p I

In a previous communication published in a recent issue of SURGERY GYNECOLOGY AND OBSTETRICS (18) I reported a survey of the literature on the use of iodized oils for diagnostic purpose with particular reference to uterosalpingography and also some original observations of my own. The work I believe establishes the value of the roentgenological visualization of the uterus and fallopian tubes after transuterine injection of iodized oils as a means of exact gynecological diagnosis in selected cases.

It is my belief that uterosalpingography not only supplements the insufflation of gas but frequently supplants it. In cases of sterility, it not only informs us whether the tubes are patent or not but also localizes the site of occlusion. Properly performed the test outlines the uterus and various portions of the fallopian tubes with great distinctness.

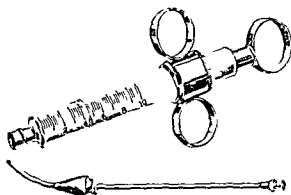
For a description of the technique of the method the reader is referred to my previous paper. The application of the test is quite simple but strict aseptic precautions must be taken. In my experience as in that of the

great majority of other workers the transuterine injection of iodized oil has been entirely harmless and I have observed no manifestations of iodism or other injurious reactions from its use.

Since my earlier paper was submitted for publication a number of important contributions on this subject have appeared. It is my purpose to mention the more important of these articles in order to make my review of the subject complete. More important however is the fact that I have observed striking therapeutic results after the use of iodized oil by transuterine injection. It is upon this phase of the subject that I propose to dwell most particularly. Furthermore brief mention will be made of the new syringe which I now use for the injections which has been improved by the addition of a manometer.

RECENT BIBLIOGRAPHY

The reader is referred to my previous article for a bibliographical survey of the subject of uterosalpingography. Heuser (16) of Buenos Aires in 1905 was one of the first to employ iodized oils for gynecological diagnosis. However since Ferris (10) article was published about the same time as Heuser's and Forestier (12) states that Portiet of France was the first to inject iodized oil into the uterine cavity for the purpose of roentgen ray study the matter of priority is rather confusing. Heuser injected iodized oil as a means of making an early diagnosis of pregnancy in women who had missed two or more periods. Roentgenograms taken subsequently showed the normal triangular outline of the uterus when pregnancy was not present otherwise the oil passed around the fetus and failed to fill the entire uterus. Heuser found that the injections were in no way injurious and did not induce abortion. On the contrary they were



l ut m e i j c t n f d d b t l t f t
i b e n p f e t e d iodized oil A manometer attached



1 Uterosalpingogram of normal genital organs. A - uterine cavity, B - internal os, C - ampulla, D - distal end of tube, E - constriction of the tubal sphincter, F - free iodized oil in the peritoneal cavity.

ineffective when attempts were made to produce therapeutic abortions thereby.

It was not long before the diagnostic possibilities of iodized oils were recognized and their injection was used for roentgenological visualization of defects in the uterus and fallopian tubes. This subject has already been covered in my previous paper and I shall merely add references to articles which have appeared since then.

Heuser (7) in 1906 added some important observations made with reference to a salpingo uterine sphincter action and the muscular contractions of the fallopian tube by means of uterosalpingography. Roentgenological pictures showed at the uterine cornu and in the cavity of the tube a space similar to the ring produced in the pylorus followed by the cavity of the tube in the shape of an ampulla. This ring is encountered in a state of relaxation or contraction according to the phase in which it is observed. It is observed in the terminal portion of the uterine cavity

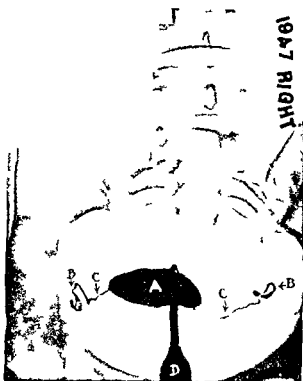


3 Case 1. Roentgenogram showing free distribution of iodized oil throughout the peritoneal cavity 4 hours after the transuterine injection. Such pictures may be obtained from all patients in whom the fallopian tubes are patent.

thus explaining why the fluids of this cavity are not readily transported to the pelvic cavity. This constricted ring closes in some patients when the horn of the uterine cavity becomes contracted as seen by the shape of the walls in this region. This explains why in the presence of uterine hemorrhage the blood does not enter the peritoneal cavity but escapes through the uterine cavity. The sphincter which in roentgenograms is seen as a black line becomes displaced with the body of the uterine cavity itself on contracting without changing its place.

Heuser's findings not only show that the uterine cavity possesses a salpingo uterine sphincter and that the muscular contractions of the tube extend to the uterine cavity but also indicate the different roentgenological phases in the tubal cavity as follows:

1. The iodized oil in the peritoneal cavity is absorbed by the tube through capillary attraction and expelled into the uterine cavity through muscular contraction.

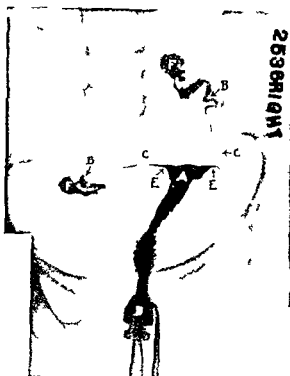


I d Sl rp t fl f tl t A th t
I d tl b f th um t f th f lu d
th l j t th h th f t ll f th thm
f th t u F spl t f th l tt th
f h f f

When there are remnants of placenta the alpineo uterine sphincter remain open in some case thus accounting for a pending infection

Remnant of placenta in the uterine cavity produce in roentgenograms a deformity of the pictures of the cavity because of the space occupied by the remnants in the uterine cavity thus explaining the deformities of the triangular picture of the uterine cavity when filled with iodized oil

On fluoroscopic examination of the uterine cavity filled with iodized oil one may observe when the cavity is occupied by some foreign body that muscular contractions occur as far as the neck of the uterus. They progress slowly sometime taking the form of undulation in the wall. In some case the contractions are energetic in other very slow. In patients with hyperthyroidism they take an energetic course. In those case in which there are remnants of abortion fibromatous etc or pregnancy the contractions are



I d Sl rp t fl f tl t A th t
I d tl b f th um t f th f lu d
th l j t th h th f t ll f th thm
f th t u F spl t f th l tt th
f h f f

very slow and in many cases they cannot be demonstrated

Bakke (2) in 1917 by means of utero alpingography demonstrated the presence of a tubal pincher not previously known. The tube at the cornua are thickened in the shape of a funnel whose base is toward the uterus. This funnel is sharply defined from the uterine cavity just like the pylorus between the stomach and the duodenum. There is a rare formation seen in picture of all normal tubes which is undoubtedly produced by a sphincter. When the cornu sphincter and uterine end of the tube are enlarged they resemble to the stomach pylorus and duodenum is still more striking. By histological examination Pomcke (31) was able to demonstrate the anatomical substratum of the sphincteric action.

Joachimovits (19) in 1926 found that injection of iodized oils entirely harmless and of undoubted value in the diagnosis and calibration of submucous and intramural uterine



Fig. 6 The tubal sphincters, particularly the left, are well shown. The tubes are patent and the oil flows freely into the peritoneal cavity. Note the large amount of iodized oil in the peritoneal cavity, although no symptoms were produced thereby. For an explanation of the letters see the legend for Figure 1.

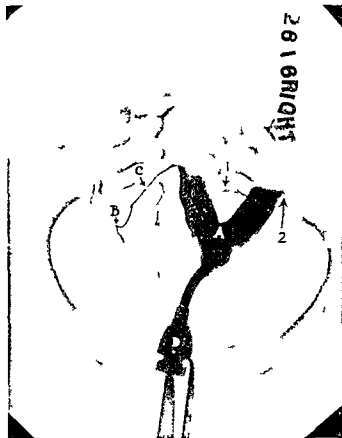


Fig. 7 Indentation produced by uterine fibroma and occlusion at the beginning of the isthmus. The occlusion of the right fallopian tube would have been overlooked had reliance been placed upon findings in the Rubin test. The condition shown here is frequently followed by placenta accreta.

myomata and also of intraligamentous tumors when combined with roentgenological visualization of the ureters. By taking the roentgenograms immediately after the injection with the patient lying down he found that contractions could be demonstrated in the normal uterus. This method of investigation makes it possible to diagnose infantilism, anteversion, retroversion and other deviations in the position of the uterus and uterine tumors also to demonstrate patency or occlusion of the fallopian tubes.

Cotte and Bertrand (8) in 1917 reproduced the illustrations presented with the article by Gregoire, Beclere and Darbois (14) in 1926 which illustrate the value of iodized oil injections and roentgenography in the diagnosis of various pathological conditions. For the diagnosis of tubal patency it proved superior to insufflation and in the differential diagnosis of pelvic tumors for example between

myoma of the uterus and ovarian cysts the method was very serviceable.

Nœlke (7) found uterosalpingography of special value in the diagnosis of tubal obstruction and the exact localization of the site of occlusion. He employed the method in 90 cases without admitting the patients to the hospital. For roentgenological visualization of the uterus and tubes he first uses insufflation of air and follows this procedure by the injection of a contrast material either sodium bromide or iodipin. Roentgenograms are made with the Bucky diaphragm. Equally good pictures were obtained with either contrast material and no untoward effects were observed.

Beclere (4) introduces lipiodol through a soft rubber tube with an olive shaped tip that fits the uterine cervix in each case. In order to avoid exercising too great pressure in introducing the lipiodol he has designed a



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F o Sh m llfb my m r o th ht l
 l tel tb myom th l ft l Th f ll p
 t b p t t Fr pl ti f th l tt
 tl lg dfo Γ u

F 8 I d t t p d dly te tb my m
 2 d cl 2 t th b m f th ht mpull
 3 I l p t m j pat tt b I n pl
 t f th l tt th l df I

special uterine manometer that is attached to the syringe with which the injection is made. The injection is made under fluoroscopic control so that the iodized oil can be seen entering the tubes and if they are patent passing to the peritoneum. Beclere has used this method in more than 59 examinations and has found it of special value for the diagnosis of tubal obstruction and pelvic tumors.

Contrary to most investigators Odenthal (8) is of the opinion that uterosalpingography with various contrast materials cannot be regarded as an absolutely harmless procedure. He reports two cases in which pathological changes resulted from the injection of the contrast material. In one of these cases 4 cubic centimeters of 40 per cent iodipin was used. There was no immediate reaction the patient leaving the hospital 3 days after the examination and feeling entirely well but within 10 days she developed symptoms of peritoneal irritation with fever. After 3 weeks of treatment the symptoms subsided.

On the basis of their clinical experience with roentgenological examination of the uterus and tubes after injection of lipiodol Gregoire Beclere and Darbois (15) in 1917 concluded that this procedure is practically harmless and of great value in diagnosis and as a guide to treatment. It shows the location, form and volume of the uterus and the outline of the uterine cavity and any pedunculated or other growths on its walls. It further shows the outline and caliber of the fallopian tubes, any obstruction and its exact location. Contraindications to its use are acute infections with fever, severe uterine hemorrhage and suspected pregnancy.

Gregoire Beclere and Darbois found that the differential diagnosis between uterine myomata and ovarian cysts which is sometimes difficult is simplified by the diagnostic use of iodized oil. In case of metrorrhagia the method shows whether or not an intra-uterine tumor is present and indicate the best site for the removal of a section for biopsy.

Luetgje (24) introduces 10 to 20 cubic centimeters of 10 per cent iodipin into the uterine cavity with minimal pressure. He does not induce preliminary pneumoperi-



FIG. 10. Showing displacement of the uterus to the right and posteriorly. The tubal sphincter is well defined. Both tubes are patent and there is free oil in the peritoneal cavity. For an explanation of the letters see the legend for Figure 1.

toneum. The roentgenograms are made immediately after the injection with a Bucky diaphragm. From his experience with this method Luettge concludes that it is of definite value in gynecological diagnosis especially of tubal obstruction that it causes no inflammatory reaction and that it can be used outside of the hospital.

According to Randall (29) roentgenograms taken after the injection of iodized oils into the cavity of the uterus and fallopian tubes indicate a sharply limited field for salpingostomy in the treatment of sterility in women. He employed this method in 18 cases of closed oviducts at the Mayo Clinic. The roentgenograms indicate that in 6 of these cases one might expect success from operative treatment for sterility so far as the condition of the tubes was concerned. Two of these patients were operated upon and in each case the pre-operative diagnosis was confirmed. One of the patients subsequently became pregnant.

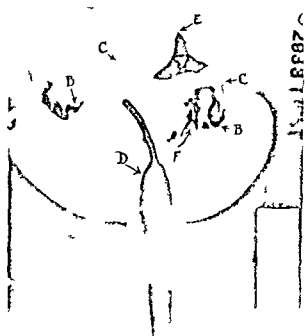


FIG. 11. Same case as in Figure 10 taken at a different angle in order to show the displacement better. For an explanation of the letters see the legend for Figure 2.

Steinharter and Brown (36) found the introduction of iodized oils and roentgenography of value as an aid in the diagnosis of intra-uterine conditions, mural fibroids, patency of the fallopian tubes, the visualization of the size and position of the uterus, the recognition of early pregnancy and in the differentiation between intra-uterine and extra-uterine tumors. They recommended it as an adjunct to the Rubin test and have found the injections to be entirely harmless.

Jungmann (32) made the roentgen ray diagnosis of tubal pregnancy by filling the uterus in one case. The filling of the uterus showed a normal, clearly outlined triangular area. There was no evidence of atony of the uterus which according to Dryoff is present in extra-uterine pregnancy. Both tubes were completely patent. At the side of the questionable tumor, the film picture of the tube showed an elliptical form. The abdominal end coincided with the angle of the tube in projection. Iodized oil had entered the peritoneal cavity through the abdominal ostium where it was visible as a flat shadow. At one point the tube was dilated to many times its normal diameter and showed a kidney-like shadow.



Γ Sh g dh t t b Th mp ll v
po t n f tl ht fl p t l dh t t th
p t f f th ut l l t f th
l tt th t g l f Γ g

This sudden alteration in the transverse section of the tube was attributed to the penetration of iodized oil into the space between the mucous membrane of the tube and the decidua capsularis. On the basis of this finding a diagnosis of extra uterine pregnancy was made and confirmed at operation.

In a study of uterosalpingography in 53 cases Reinberg and Arnstam (1926 and '30) found that whereas the normal uterine cavity is a symmetrical triangle the height of the triangle in the forward and backward displacement of the uterus is shortened with the result that it assumes a spindle or segmented form. With the fluoroscope and serial roentgenograms they observed movements of the uterus which they believed to be due to change in the muscular tone. In most cases they found that the uterus tends to expel the contrast material through the vagina by a sudden contraction of its wall. This muscular contraction may occur early or late but usually 15 to 20 minutes after the injection



I 3 Sh d bl t th p v Th
ht d d ut t th m d th d l
h l t b t t If b t th d d p t l
th d l Th bl d f t th h l
d d t th p f th m Th m tr l l t
d t th f t th h l f th l t
b l N t th t th m tt h l t th pt m
b t tl d ll t B f th l l l
p d l m tr m l f d h pt tl
f pl t t f l A l tl l
h t d th l ft d d th l t h l t
l d d mm t ll D mm t l f t
t ru t j t l h d f l f t l l
l l l p l m l l l l l

tion of the contrast material. If the uterus empties itself early the same thing occurs when another attempt to introduce the contrast material is made and it is impossible to make a roentgenogram in such case. There is in addition to this method of emptying the uterus a second method viz the gradual expulsion of the contrast material through the fallopian tube into the peritoneal cavity. I cristic muscular contractions in the uterus could not be demonstrated with certainty.

Reinberg and Arnstam described a phincter apparatus at the uterine end of the fallopian tube not previously recognized. Under normal circumstances it is capable of shutting off the uterine cavity from the lumen of the tube by a contraction of the annular muscle fiber in the parietal uterine wall. The width of the zone of contraction varies from 1 to 1.5 millimeter. The closure is not always complete. By serial roentgenogram an active peristalsis of the wall of the fallopian tubes causing a rapid movement of the

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Fig. 14. Uteru bicornis. For an explanation of the letters see the legend for Fig. 13.

contents could be demonstrated. This movement was an antiperistalsis except in one instance in which a properistalsis was demonstrated in that the uterus after expulsion of its contents into the vagina was again filled from the fallopian tubes.

With regard to the clinical applications of uterosalpingography Reinberg and Arnstam found the measure of greatest value for the following purposes: (1) to demonstrate the patency of the fallopian tubes and localize any obstruction that may be present; (2) to differentiate uterine tumors particularly submucous and intramural myomata; and (3) to diagnose early pregnancy which is shown by a filling defect and a rounder shape of the uterus due to atony. They never observed an abortion due to the injection of iodized oils and believe that its careful use is permissible in selected cases.

Nahmmacher (6) used uterosalpingography in 50 gynecological cases and was able to corroborate the accuracy of the procedure by the operative diagnoses. Contrasting with the triangular shape of the normal uterine shadow, there is a clear space at the point of flexion in retroflexion. In metritis Nahmmacher found enlargement of the uterine

719 RIGHT

Fig. 15. Showing a complete occlusion of both tubes at the cervix. For an explanation of the letters see the legend for Fig. 13.

cavity and dilatation of the cervix. In uterine tumors there was a characteristic change in the shape and position of the uterine cavity. In ovarian tumors on the contrary the outline of the tubes proved to be normal. Chronic adnexal inflammation showed its presence by dilatation and stricture of the tube and finally by displacement of the uterus. Like most other workers Nahmmacher considers uterosalpingography the best and safest means of demonstrating the fallopian tubes and he observed no injurious effects in any of his 50 cases.

Cott and Pierre (9) found uterosalpingography superior to insufflation of the fallopian tubes for determining the cause of sterility, confirming the work of other investigators to the effect that this procedure not only demonstrates the presence of obstruction but also localizes the site of the occlusion. Furthermore it indicates the nature of the operative treatment required that is salpingostomy, excision of the pavilion of the fallopian tubes, resection of the isthmus with implantation

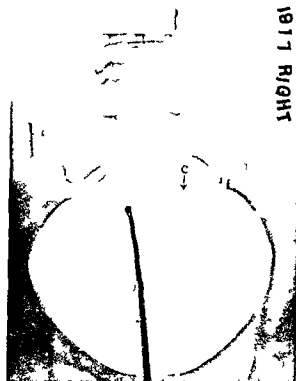


l o s l n lu f th l ft be t th
Th t s h l f m l b t d pl d t
th l ft th l ft fl p n tub l d l t th r
A m ll p t f th t m of th ht b c m
pl t ly flled th l b t the m d f th t be
mpl t l l d d

into the uterus or—in cases of disease of the entire tube—transplantation of the ovary into the uterus. In the experience of Cotte and Pierre uterosalpingography proved especially useful for the differential diagnosis between *hämato salpinx* and ovarian cysts as a substitute for intra uterine exploration in cases of metrorrhagia for the diagnosis of malformations and hypoplasia of the uterus in dysmenorrhœa and amenorrhœa and particularly for the recognition and localization of tubal obstruction in case of sterility.

THERAPEUTIC USE OF IODIZED OIL IN GYNECOLOGY

In my earlier work with iodized oil my object was only to obtain roentgenograms of the lumen of the uterus and fallopian tube for diagnostic purpose. By this means I was enabled to recognize normal fallopian tube (Figs 4, 5 and 6) occlusion of one tube



l 7 Th m l 6 ft th l l
o l b b ll d t d f d d h bec nt
d d to t th l t f th t N t th t th
d d d t d t th l ft p d t th t
p d h t th l ft fl p t ul p g th t th d
t lly a f l f t f p t t t t
h d d b h d th t ha l Th ht fl p
t be h w th m mpl t fill th d p
ll t t c th thm f th ht fl p t t

only (Figs 7 and 8) occlusion of both tube (Figs 15 and 16) encroachment on the uterine cavity by neoplasm (Figs 7, 8 and 9) uterus bicornis (Fig 14) and septate uterus with pregnancy (Fig 13). In cases of occlusion moreover the exact site of the occlusion was determined (Figs 7, 8, 15 and 16).

However I have been reluctant to inject iodized oil in cases of pregnancy. Although Heuser state that diagnostic injections do not interfere with normal pregnancy, I have been deterred not so much by fear of causing abortion as of doing possible injury to the offspring. In my own opinion uterography should be employed for the early diagnosis of pregnancy only when therapeutic abortion is contemplated and injury to the offspring is of no importance.



FIG. 18. Showing dilatation of the fallopian tubes with obstruction beyond the ampulla. The fallopian tube is obstructed beyond the ampulla and are definitely abnormal. There is no free iodized oil in the peritoneal cavity. Twelve cubic centimeters of iodized oil were required to obtain this uterosalpingogram. For an explanation of the letters see the legend for Figure 19.

Invariably before taking uterosalpingograms I gave my patients preliminary insufflations of oxygen or carbon dioxide if these measures had not already been employed. At the outset I had some misgivings lest the oil might cause injury to the peritoneum or abdominal viscera or transport infectious material from the fallopian tubes into the peritoneal cavity. Subsequent experience proved that these fears were not justified.

If the objections which have been mentioned were valid they would apply to an equal degree to the Rubin method. Yet even though the Rubin insufflations are widely used subsequent intra-abdominal complications are infrequent and practically all workers are now agreed that uterosalpingography may be employed with the same measure of safety.

At first I did not suspect that injections of iodized oil might have possible therapeutic value in gynecological conditions but I became interested in this possibility when I realized that the oil could enter the peritoneal



FIG. 19. The same case as in Figure 18 with the exposure taken from the oblique position. For an explanation of the letters see the legend for Figure 18.

cavity without causing injury. It was reasoned that since an oil capable of slowly liberating iodine could be injected so as to reach the peritoneal cavity without entailing serious consequences the use of this substance might possibly be attended with therapeutic advantages.

I was encouraged in my investigation of the therapeutic possibilities of iodized oil by the experience of H. M. Little (23) of the Montreal General Hospital whose work I have quoted elsewhere. Little successfully used injections of 10 per cent spirits of turpentine in liquid paraffin in the treatment of infected fallopian tubes as follows. After laparotomy the pus if present was aspirated through a puncture in the wall of the tube and 1 to 3 cubic centimeters of the turpentine paraffin mixture was slowly injected the abdomen was then closed without drainage. After this treatment Little observed no untoward effects and some of the patients subsequently gave birth to healthy children. This procedure of course should be attempted only after acute symptoms of adnexal inflammation have subsided.

It is perfectly plausible that an iodine liberating preparation proved roentgenologically to enter the fallopian tubes after intra-uterine injection should give therapeutic results similar to those obtained by Little.



f t Th sam f 8 t k 7 h
 i t t Th t g m h th t the d d
 l h g the d th d te d d d l ed po t f the
 m j h B l l n dly th h a dly v absorpt
 f th d d l f m th f l l p tub d th t m

In that event it would be obviously better to employ the treatment by this route rather than after laparotomy.

A survey of the literature on the therapeutic use of iodized oils yields very little information. Yet it will be recalled that lipiodol was originally used for therapeutic purposes being administered by intramuscular injection for the purpose of slow iodine medication. It was only when opaque spots were noticed on roentgenograms long after such injections that Sicard and Foretier (33) in 1911 applied it to roentgen ray diagnosis. In our enthusiasm for the diagnostic use of iodized oil we have largely forgotten its original therapeutic application. Recently however Imkoff (11) has obtained excellent results in the treatment of surgical tuberculosis by intramuscular injections of sterilized peanut oil combined with a small quantity of tincture of iodine.

Sicard (3) remarks that lipiodol possesses noteworthy therapeutic properties. In his experience rheumatic pains are considerably improved by local injection; the introduction of 5 to 10 cubic centimeters into the painful region sufficing. The injection should be deep, preferably reaching the level of the



F Sam e f e 8 t k m tl
 ft first t lp graphy Th p t p t
 n rm l t lp g m Both f l l t l e a p t
 t d th d d l to te th p t n l t
 th h th ta bd m l C mp th l
 s y d o d t that th f l l p t be h t
 ly b m p t t b th e l g d the rm l
 f t F pl t n f th l t t e th l k l

bone. Sicard obtained excellent results with this therapy in sciatica. In lumbago sacral epidural injections worked wonders. For the articular pains of arthritis peri-articular and sometimes intra-articular injections of lipiodol likewise proved of value.

Torto (37) believes that the subarachnoid injection of iodized oil is of value in the treatment of Pott's disease. Other than initial headache and paresthesias in the lower limb he has observed no harm following this procedure. Torto is of the opinion that the direct iodine medication to the region of the diseased vertebrae should constitute ideal therapy and that the slow but continuous absorption of iodine in proximity to the lesion should be of distinct therapeutic value. However further investigation is required on this subject.

Graevinghoff (13) in 1917 reported the use of lipiodin in a case of staphylococcus infection of the ventricle of the brain with uppeurpation. Six cubic centimeters of lipiodin were injected into the right lateral ventricle which was markedly dilated. Several convulsions occurred immediately after the injection. This reaction was followed by definite improvement in the general condition; a drop in the



Fig. 22 The same case as in Figure 21 after the oil has been allowed to drain off and a sound introduced to orient the position of the uterus. Compare this picture with Figure 20 from the same patient which shows tubal distention but no free oil in the peritoneal cavity 3 days after the injection. For an explanation of the letters see the legend for Figure 19.

temperature, gain in weight and reduction in the number of convulsions. The improvement continued for 2 weeks but after that period the child grew worse and died 25 days after the iodipin injection. Autopsy showed nearly 4 of the 6 cubic centimeters of iodipin injected still in the ventricle. The other ventricle showed inflammation of the walls which were covered with a thick suppurative exudate. The walls of the right lateral ventricle were smooth and normal. This change in the right ventricle Graevinghoff attributed to the action of the iodipin.

In one case of hemorrhagic tuberculous pericarditis Castex (5) performed a therapeutic pneumopericardium. As the roentgen ray appearance suggested the presence of adhesions 10 cubic centimeters of lipiodol was introduced after the withdrawal of 100 cubic centimeters of exudate. The roentgen ray examination after this injection showed no evidence of adhesions. The lipiodol penetrated into the meshes of the inflamed tissue of the pericardium and remained there. Repeated injections were given at intervals of 5 to 14 days but they had no definite influence on the pathological changes in the pericardium the disease running the usual

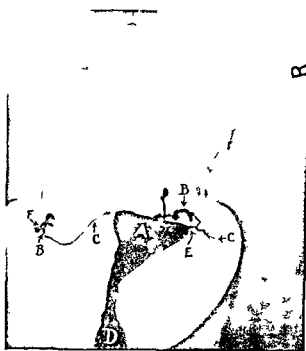


Fig. 23 A misleading uterine oil absorption from which one could believe that the left fallopian tube was occluded. Compare this figure with Figure 4. For an explanation of the letters see the legend for Figure 19. The iodized oil shows the uterus to be of normal size. The right cornu is slightly displaced to the right; the cervix to the left. The right fallopian tube is well filled with iodized oil throughout its entire extent. The left tube is not shown. Not that there is a well defined sphincter at the right cornu.

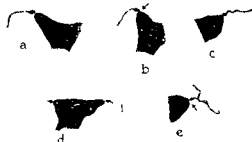
course. Injections were well tolerated. There was little or no absorption of lipiodol as was demonstrated roentgenologically.

Many years ago McShane (25) injected oil of sesame into the trachea and bronchi for therapeutic purposes. Jones and Jamison (21) believe that slow liberation of iodine following the injection of iodized oils into the bronchi exerts a distinctly antiseptic influence and that iodized oils are therefore of value in the treatment of lung abscess, bronchiectasis and chronic bronchitis. Ballou and Ballou (3) note that iodized oils are beneficial in the treatment of bronchiectasis lessening the cough and diminishing expectoration.

Cott and Bertrand (6) in 1926 were perhaps the first to suggest the therapeutic use of iodized oils in gynecology. They observed at that time that lipiodol has a powerful antiseptic action and would destroy any microorganisms in the fallopian tube after intra-



R



f

uterine injection. Although they used lipiodol for diagnostic purpose in more than 5000 cases of acute or subacute inflammation of the fallopian tube they never noted any rise in temperature or any unfavorable reaction due to the introduction of the oil. They therefore suggested that the injection of iodized oil might prove a useful therapeutic measure early in the course of salpingitis and that it might result in early recovery and prevent tubal obstruction.

Jorachimovits (1906) observed that in case of profuse leucorrhoea and of non-menstrual endometritis there was a marked diminution of the uterine discharge after intra uterine injection of iodipin the substance remaining in the uterine cavity for a considerable period.

Cotte and Pierre (9) gave intra uterine lipiodol injections in case of acute adnexal inflammation without harm. They believe that in certain conditions the iodized oil

may have a favorable influence on the pathological process in the fallopian tube.

Having in mind a possible therapeutic effect from the trans uterine injection of iodized oil and also being reluctant to use force in case of salpingitis on account of a possible danger of forcing septic material through the tubriated extremity I have made it a practice to inject the oil slowly and with great care. Under my direction a Luer syringe with a manometer attachment is being perfected in order that the pressure may be readily determined. A pressure of 30 to 40 millimeter is sufficient and ordinarily the amount of material required to fill the uterus and fallopian tube is 4 to 5 cubic centimeters. By a preliminary examination of the internal organ one can usually estimate the amount of oil required in a given case. Furthermore the roentgenogram are made concomitantly fluoro copy may be used to gauge the amount required to fill the uterus and fallopian tube without forcing excess into peritoneal cavity.

In several of my cases of quiescent or chronic salpingitis the iodized oil appeared to have pronounced therapeutic effect. The most striking results were obtained in Case 14 the details of which are given under the case reports. When the injection is being made for diagnostic purposes only it is not necessary to take the pressure.

It cannot be emphasized too frequently that if too much force is used in the injection a spasm may occur in the musculature of the uterus and the fallopian tubes as a result of which the patient experiences a sinking sensation or even sharp pain. Earlier in this article I have referred to the sphincteric action of the muscular bands at the uterine cornua commonly called the 'tubal sphincters' and this function is exemplified by the findings shown in Figures 5, 6, 8, 10, 13, 4 and 5. The existence of this sphincter furnishes the real reason why force should be avoided in the injection of iodized oil or the insufflation of gas. For one who has not required the sense of touch by which to gauge the amount of pressure being employed the use of a syringe with a manometer attachment has obvious advantages.

With regard to the application of the Rubin test one must bear in mind that the formation of a pneumoperitoneum during transuterine insufflations of gas does not give in absolute diagnosis concerning the permeability of the fallopian tubes. In Cases 5 and 6 insufflation was followed by all the evidences of free entrance of air into the peritoneal cavity. The mercury in the manometer rose only to 100 and 104 millimeters respectively and then dropped rapidly to 60. Shoulder pain was present and roentgenological examination established the presence of air in the peritoneal cavity. Yet the uterosalpingograms proved that only one tube was patent in each case.

In Case 8 high manometer readings reaching 10 millimeters were obtained during the insufflation of oxygen notwithstanding the fact that several attempts were made during the same sitting. Yet when iodized oil was injected the fallopian tubes opened up and showed the true condition to be not obstruction of the fallopian tubes but a shortening of

the right adnexa and a displacement of the uterus to the right causing a kink in the fallopian tube. In Cases 12 and 13 the insufflation readings were high without a secondary drop and it was the uterosalpingograms after the injection of iodized oil that located the occlusion which was at the cornual ends of the tubes.

I do not mean to belittle the value of the Rubin insufflation test for the fact that this diagnostic procedure has been widely utilized the world over is sufficient evidence of its usefulness but I do believe that uterosalpingograms taken after the transuterine injection of iodized oil give a more accurate and a more detailed picture of the pelvic lesion.

It is important to take several plates at different angles otherwise several shadows may be superimposed and thus lead to an error in diagnosis. In Figure 2, for example the left fallopian tube appears to be occluded but in reality it is hidden behind the uterine shadow as shown by Figure 4. It is advisable to take one picture after the oil has been allowed to drain off from the uterus. As some oil remains in the uterus and fallopian tubes for a time shadows of these organs will persist. On the other hand the persistent absence of a shadow of the fallopian tube in uterosalpingograms taken when the uterus and tubes are filled with oil and again after the oil has been allowed to drain off would indicate that the oil did not enter the tube and that it is therefore occluded. The latter condition is shown in Figures 16 and 17 which indicate that the left tube was entirely occluded while the right was only partially and incompletely filled.

In my investigation I employed hipiodol which is a chemical compound of poppyseed oil and iodine solution.

CASE REPORTS

CASE 1. Normal uterosalpingogram B. C. aged 35 married 12 years complained of primary sterility. Pelvic examination revealed an anteverted but freely movable uterus of moderate size. The cervix was directed downward and forward. The introitus was normal. The adnexa appeared to be normal. The patient received a transuterine injection of 5 cubic centimeters of iodized oil after which the uterosalpingogram was taken. The result is shown in Figure 2 which may be taken as an illustration of

th no mal g nital organs A roentgenogram taken 4 hours aft r th inject on sh ed th io i zel d fr ly d i t ubel throughout the peritoneal cavity (Fig 3)

CASE 5 Sharp ante flexion of uterus L C ag d 5 m rru l 3 v ar complain d f p m ary st ility O p l v i examinati n th ute us w f un l to b h f l y ntel vcd but freely m vabl Th adnex r n t palpable When ov g n suffusions v g r n th pr ure reached oom llim t r vith ut a fr p in the mercury Se eral att mpts rem le to f c th ga through but th v r c all n ucc ssul s far s ou l b lct rm n l Th c as no fall in th pr sur a s ultat on vas n gative o ntg n l g l xaminati n d d not hov pn umop i n um l th p ti t d d not mpla f h ilder pain Th pat nt re el an nje tion of 45 uli numet rs of iodized oil aft r v hich s e al r ntg noz am s er taken Notwith standg the ult of th Rubin t st the fall pian tubes v r f und to b pat nt and the e a fr oil in the p t n al cavity The typal p etur of sh p ante flexion is sh n in Fig e 4 Th th type of ca n h h th Dudl v operation on th cer x may eff t a cur of st ility

CASE 3 Along cervical cervix the right fall pian tube high in the p l is S W ag l 32 mar i f s ar compl n d of p m ary st ility On pcl i amination th ut rus as f und to b f small z an l som hat d pla ed to the right Th vix a c y long a l n al with a pinhole vter al Aft the injecti n of 4 cubic c timet rs of io i zel oil th tetro salpingog am v i lly c nfi m l th findng obtan d on man al xamination (Fig 5)

CASE 4 Mark l sphincter acti n at the uter ne cornu B B agel 2 mar id yea s com pln d of p m ary ter l ty Th utero alpn g am as taken aft r the injecti f 8 cubic c e timeters of li el oil (Fig 6)

CASE 5 Inflant on produ l by a uter fibroma a d o clusi n at th beginning f the i th m s S I agel 13 m rru l 2 y e rs compl n d f p m a y st ility Her m nstrual pe od occ red e v 3 ck and lasted 7 days On manual exam i ation th ute us v a found t b ante flexed and lightly enlarged Ther wer t v o terine fib myo m ta one ab ut 3 centim ters in diam ter at th fun l ut m j r p o tion ppar tly fo ming part of th ut n all the oth r bout 3 centim et s n l im t r lo t d at th right c nu Two days pri to th inj ct on of odi d oil the pati nt v as i u l l t d ith o y gen As v o shov n by all th tandar l s gn ncl u ling the ro ntgenogram the gas nt r d the p rit neal cavity easily and gave no n l ation of the i ten e of ob t ruction at the right c r u Th ut alpn g ram outlin d the ind n tati n pr lu l by the fib myoma at the fun lu nd l o sho d that the right thmus a o l u l l (Fig 7) Shoul th pati nt become f gn t n may exp ct the d l pment of f l h t a t i n a fibroma s locate l may

produce an atrophy of the overlying en l metrium a condition hich i often the for runner of placenta accreta

CASE 6 Occlusion of the fallopian tube at th b ginning of the ampulla R D aged 30 c m plain d f p m ry sterility Menstruation occurr d ev ry 4 weeks v as of 4 lav luration painful and ithm lerat flov On manual exam nati n th ut r s v as fo nd to be of moderate siz an l fr ly movabl O the right side of the uteri isthmus v fibromyoma bout 6 c ntmet r n diameter v r palpat l Aft r in ufflati n ith o v g n the pr ssure ret hed only 104 m llim t rs and droppe l apidly t 6 m l l m t r It would e m from the c findngs that the tub wer fat nt But the it r salpn g am tak n fter the nje ction of i d el l (Fig 8) h wed th ght fall pian tube t b o lud l at th b ginning of the ampulla an l al o i licat l r n a v l p es ur from the fibr my ma on th right id of th ut rus

CASE 7 Iedun ulat l uteri v fibromyoma en cro hung upon the ut rin cavity I S ag l o marri l 4 yea rs had had stillb th t t m Ro ntg nologic l study afte th nje cti n of odi l oil (Fig 9) sh ed both fallopian tub to be patent

th a small fiboma on the right ile n r a hing upon the ut rine cavity Ther v a la ger p d u culat l fibroma on the left side

CASE 8 Displa em nt of the teru to the ght an l po te v l vcl d f n d sphu t r at the r rin ornu E A ag d 34 m r d 6 yea rs complain l of p m ary st ility Soon after marriag h as ill f r v eral v ek with p l v ic inflammation Insufflation th oxygen r ulted in a g re ur of 210 mill met r and the e was no drop The pr of gas in the pe ton al cavity co ld not be demon strated by auscultation shoul d r pain or ro ntg n gram Aft th tra sut n ije ction of 6 c bi centimeter of i l el l the ute salpn gogram (Fig 10 a d r) sho ed fre oil i th p rit n l cavity p ovi g th t both t bes we p e nt Th al sh d th uter st b markedly d plac d to the right and bak ard into the h llo v f th sa rum Ther v a v l l d f i d spl ct r th left uteri co nu

CASE 9 Ampull y p r t on f th tube adh t th ut r R L ag d 33 marri d 3 y a g a hi t r v of hav ng had fclvi dis a e se ral v pre ously On manual exam nati n the t u fou d to be som hat larg lan t l eel t th ght pel c v l l in ufflati with ocula i met rs of o v g n ult d n a pressure f 150 millimeters dropping to oo millm t r Th entra ce of g into the p r t neal t v a n firmed by auscultati n r f v shoul d r pain a l pneumop tuncum oentg nolo ally v ual l l The ut o lpn g ram (Fig 11) sh ed b th fal pian tub s to be patent but th ampull y p r t n of th ght tub s adh r t to th po t r sur fac of the uterus

CASE 10 Do ble ute u ith p g an v Mr F 6 we k s pr g ant a f un l o m u l amination

to have a double uterus. The uterosalpingogram taken after the injection of iodized oil revealed the conditions graphically (Fig. 13).

CASE 11. Uterus bicornis. S. D. aged 35 married 5 years. Complained of primary sterility. After the injection of iodized oil the uterosalpingogram showed a uterus bicornis (Fig. 14).

CASE 12. Occlusion of both tubes at the cornua. C. L. aged 30 married 7 years complained of primary sterility. She had suffered formerly from profuse leucorrhoea. On manual examination the uterus was found to be of moderate size ante flexed and movable. The adnexa were thickened. After insufflation with oxygen there was no evidence that the gas had entered the peritoneal cavity. The uterosalpingogram taken after the injection of iodized oil (Fig. 15) showed occlusion of both fallopian tubes at the cornua.

CASE 13. Occlusion of one tube at the cornu. S. G. aged 9 married 6 years complained of primary sterility. Eighteen years previously she had had an operation for ruptured appendix. 8 years previously one for intestinal obstruction. On manual examination the uterus was found to be moderate size ante flexed and sinistrotorted. The adnexa were not palpated. With oxygen insufflation the pressure reached 200 millimeters and there was no drop. After the injection of iodized oil the uterosalpingogram (Fig. 16) showed a uterine shadow of normal size but displaced to the left.

A small portion of the isthmus of the right fallopian tube was incompletely filled with the oil but the remainder was occluded. The left tube was occluded at the cornu. In order to remove any doubt that the left fallopian tube might be patent but hidden behind the shadow of the uterus a second uterosalpingogram was taken after the oil was allowed to drain from the uterus (Fig. 17). This picture likewise failed to reveal any shadow referable to the left fallopian tube.

CASE 14. Therapeutic effect of iodized oil. I have referred to this case in my previous paper in SURGERY, GYNECOLOGY AND OBSTETRICS but I am mentioning it again because I have subsequently observed a remarkable therapeutic effect following the injection. M. B. aged 34 had no children. She had had an abortion 11 years previously and was very ill at the time. Since then she had suffered from abdominal pain which was worse at the menstrual periods. Backache was severe. Pelvic examination revealed a retroposed uterus of moderate size. The fallopian tubes were thickened and readily palpable. There was more pronounced thickening at the distal portions giving the impression that the tubes were adherent to the lateral walls of the pelvis. The patient received an injection of iodized oil on February 8, 1917 and was subjected to roentgenological study. The roentgen ray findings are shown in Figures 18 and 20.

In November 1927 10 months after the first uterosalpingography another roentgenogram was taken after injection of iodized oil. A normal utero-

salpingogram was obtained (Fig. 1 and 2). Both fallopian tubes were patent and of normal contour and free iodized oil was seen to enter the peritoneal cavity. There was also a well defined sphincter at the uterine cornu on the right side. We cannot disregard the possibility that the injection of iodized oil 10 months previously was the essential factor in bringing about the restoration to normal conditions.

CASE 15. Misleading absence of a tubal shadow in uterosalpingogram. R. J. aged 29 married 9 years complained of primary sterility. Soon after marriage an abdominal operation had been performed for pelvic disease. Four insufflations had been performed within a period of 3 years without obtaining entry of the gas into the peritoneal cavity. After iodized oil had been injected the uterosalpingogram seemed to show occlusion of the left fallopian tube (Fig. 3) but when an exposure was made from a different angle (Fig. 24) it was apparent that the left fallopian tube was not occluded but merely concealed behind the shadow of the uterus. The finding in this case emphasizes the importance of making plate from different angles.

SUMMARY

1. The consensus of opinion of the great majority of investigators who have employed iodized oils for roentgenological visualization of the female genital organs is that the procedure is entirely safe and harmless and a most valuable addition to our equipment for making gynecological diagnoses. In my experience it not only supplements but frequently supplants insufflation of gases.

Uterosalpingography gives us a vivid picture of the conditions existing within the female genital tract.

2. The most valuable use of uterosalpingography is for the recognition of occlusion of the fallopian tubes and the localization of the site of the obstruction.

3. In many gynecological disturbances uterosalpingography gives us exact information that can be obtained by no other means.

4. There is a definite sphincteric action at the uterine cornu sometimes called the tubal sphincter.

5. My experience leads me to believe that the transuterine injection of iodized oil may have definite therapeutic advantages in subacute and chronic conditions of the fallopian tubes.

6. A case is described in which uterosalpingography revealed dilatation and occlusion of both fallopian tubes but in which a

second uterusalpingography 10 months later gave an entirely normal picture. There is reason to believe that in this case the slow liberation of iodine within the fallopian tubes had a pronounced therapeutic effect.

A new syringe equipped with a manometer and specifically adapted to the trans uterine injection of iodized oil is described.

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- AR TAM O I d R N RG S A De kl he
B l t g d M t salp o phi l tsch
d C l l R tg n t hl o 6 64
B AAE S N P l m n ryc mm c t o t sal
p n apl y Act ob t tgy e S d 97
6
- 3 B D H d BALL H C Tl ff t f
j t flp od la d th t f ts d ppe nc
n m l d d a d l C nad M A J
97
- 4 Bf M Fe h q d l j t tra té e
d l l l d l gn t c gyn c lo ju
Gy c l 97 47
- 5 C STR M I L p d l b d R tg t
h g d n n O M d kl 97
x 9
- 6 C ITÉ (d B KTR t P I t e m t n
flp d l d t b ft th j t flp d l
t l ty d dysm l a B ll So d ob t
t d gy d l 96 3
Id m l tg phy f th uteru d t bes
Cyn et bst 96 8
- 9 Id m L pl t d l q ed l t c t d s
t mp p è j t d lp d l J d d l t
d l t l 07 4
- 10 C TIE (d LERR B P d l e m t
f tl t ru d t b ft lp od l j t
I m d gy c d b tét t d p d t 96
- FRIL L I t d ph l ff ct s
t r e ll t e p t l d t b me j
d r l l t d é trol 95 433
l N A l j t o s t m c l d l l
d t l l d l m d l t r a t m t l l
t b e l h l P e d h 97 lx
363
- 11 HER Cted ly St h te d Bro l c t r
3 GAE L C W J d p c d M k r
B h dl d t n e L t d d H
t k l kl th P Wch h 97 43
- 4 C P Bf C d D o t E m
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t l t j l ch 96 633
Id l l od n t gynec l q Cyncl l
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- J F P H J a d J m o C N t o th e
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- J N M G b t l l h h gyncl l h P t
g blder 7 t h l f Cy ek 927 l 997
- 3 IITTL Cted by Ja h J C n at t e tm t
f d s d ad Cl M & S g 97
175
- 4 L LITG W S lp g ph Mon t hr f G
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- 5 MCS Cted by Jo d J m l t B
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- 7 N E W D Ut S lp g ph d h
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9 693
- 8 O r W U be G f h d Ut S lp
k pl Ze t l l f f yn k 9 l 84
- 9 K o LL L M L p od l j t f th t d
o d t Am J O l c y c 97 457
- 3 Rk C S A d A O I M t sal
p g l h R t t d t d be d A t m
d l l l d t t h h d L l t
l tsch d C b d k e t t hl 96
x 54
- 3 R c O C t l by B k l t
3 SICARD J A l p d t c y lp t p A h
l med y p l 96 38
- 33 St ri J A d l r J M th d g l
d pl t d l g i p l h l d (p l l)
B ll t m m So de h d P 9 l 463
- 34 Id m R d l l l l t n th l d l
B t J K l l 06 39
- 3 Id m L t d t d l pl 6 d 16 cap
l c t d d (l i od l) R m d d B l
9 57
- 36 STRIN AR E C nd Br S I t t bes w th
m nat f th t ru d f l l p t 97
od ed l J Am M A 97 l 97
- 37 To l d l l l bp d l t t ra f 97
p rap l l t t h A t l l h 9
6

BENIGN PROSTATIC HYPERTROPHY

A REVIEW OF ONE THOUSAND CASES¹BY VINCE C. HUNT, M.D., F.A.C.S., ROCHESTER, MINNESOTA
D. I. S. G. M. Y. C.

EXPERIENCE in the treatment of benign prostatic obstruction during recent years has led to the development of certain principles which have contributed materially to the reduction of the mortality rate and to the safety of surgical treatment of the disease. Recognition of disease associated with prostatic obstruction directly or indirectly the result of the obstruction as well as recognition of disease coincident with prostatic obstruction incident to the age at which prostatic disease occurs has served to weld the interest of the internist, urologist and surgeon in the treatment of this condition.

Often grave organic disturbances are associated with prostatic obstruction and although obstruction may be primarily significant the coincident organic disease must be reckoned with in the treatment of the patient. The stresses and strains of life result in degenerative changes in the cardiovascular system. The renal excretory mechanism is usually directly affected by prostatic obstruction and renal insufficiency results; however renal function may be impaired directly by organic disease of the cardiovascular system in the absence of prostatic obstruction. Willius studied the records including electrocardiographic data of a large series of cases of prostatic hypertrophy and noted cardiovascular disease in 42 per cent. He concluded that the incidence of cardiovascular disease is higher with prostatic obstruction than with many other diseases during the same decades indicating that cardiovascular disease is aggravated by persistent urinary retention.

Unquestionably renal insufficiency is a factor in decreasing cardiovascular reserve in prostatic hypertrophy. The improvement of the cardiovascular reserve coincident with improvement of renal function following gradual decompression of the bladder and prolonged urethral or suprapubic drainage is

noteworthy in conjunction with Willius' observation on the incidence of cardiac disease in cases of prostatic hypertrophy. I have observed numerous patients in uramic states and on the point of a cardiac break whose cardiovascular renal reserve has been so restored by drainage that operation could be performed safely and successfully.

It is imperative to the successful treatment of prostatic obstruction that the condition be looked on from a general medical point of view, not alone by the urologist as a disease of the urinary tract, not alone by the surgeon as a lesion requiring operation, but by the internist as a systemic disease for there are aspects which may be best appreciated by the physician.

I have recently reviewed a series of 1000 consecutive cases of benign prostatic obstruction in which suprapubic prostatectomy was performed. The review serves as a basis for certain facts and observations presented here.

INCIDENCE AND SURGICAL INDICATIONS

True adenomatous hypertrophy comprises about 85 per cent of benign obstructing prostatic lesions, the remaining lesions being of the inflammatory or prostatic type. While the inflammatory type is encountered often at an earlier age than adenomatous hypertrophy, there is little difference in the age incidence in cases of obstruction and retention from the two types of glands. Prostatic fullness and enlargement is found on careful digital examination of more than 50 per cent of men aged 50 years; however the incidence of obstruction and the symptoms of benign prostatic disease are rare at that age or under that age. The average age in this series is 64.2 years (Table I). The amount of enlargement of the gland can often be ascertained on careful digital examination. A small gland may produce intra urethral obstruction and complete retention. On the other hand a

TABLE I—AGE OF ONE THOUSAND PATIENTS

S	d	les	P	t	P	t
40-45			3		3	
46-50			13		3	
51-55			8		8	
56-60			177		177	
61-65			303		303	
66-70			6		6	
71-75			13		3	
76-80			25		5	
81-85			6		6	
86-90					1	

Old	t	p	t	h	y
1	es	p	f	y	
3	1	f	p	m	th
7	1	f	p	m	h
3	p	f	p	m	h

huge intravesical gland may provide adequate urethral passage without urinary retention. The moderate sized gland is the usual enlargement productive of retention frequency difficulty and so forth (Table II). The large gland (graded 4) becomes surgical at a slightly later age than the smaller gland (Table III) indicating that even though there is very marked intravesical enlargement mechanical obstruction may not occur early.

Experience has established the indications for operation on the basis of prostatic enlargement and residual urine. Except under the conditions of moderate or marked enlargement of the gland without urinary retention or residual urine productive of frequency pain difficulty and so forth should prostatectomy be undertaken without reservations on the amount of benefit that may be expected? Cystoscopic examination is hardly to be recommended in all cases of prostatic obstruction however a small gland with no appreciable enlargement but with symptoms simulating those of prostatic disease without obstruction usually requires cystoscopic examination. Bratsch and his associates have followed the principle of employing cystoscopic examination only in those cases in which observations on digital examination do not unreservedly explain the urinary symptoms. In other words without entering into a consideration of the symptoms and diagnosis of prostatic disease it is essential that all such cases should be given careful urological consideration. Too often normal prostate gland has been removed for symptoms produced

TABLE II—DEGREE OF ENLARGEMENT OF PROSTATE GLAND DETERMINED IN EIGHT HUNDRED AND SEVEN CASES BY RECTAL PALPATION CYSTOSCOPY OR OPERATION

Enlargement	Cases	P	t
Graded	79	8	7
Graded 3	39	48	5
Graded 4	74	33	9
Graded 5	63	7	8

by lesions higher in the urinary tract and readily revealed by careful examination. Retention and residual urine when definitely attributed to the prostate form the true indications for prostatectomy. It is questionable whether prostatectomy should be considered in the absence of residual urine or retention unless the gland is extremely large and frequency resulting from decreased bladder capacity causes disability. Certainly prostatectomy for the removal of a small gland not producing obstruction but for the purpose of relieving the major symptom of frequency is not accompanied by results which would justify the operation. Obstruction must be present to some degree before one may expect justifiable results and usually the results are good in proportion to the degree of obstruction present.

In this series of 1000 cases urinary retention requiring catheterization had existed in more than 50 per cent. The retention varied from one acute attack to chronic or continuous retention requiring constant catheterization. About 23 per cent of the patients on admission to the clinic or to the hospital had either complete retention or were retaining urine to the full capacity of the bladder in many instances there was involuntary leakage. This is a higher incidence than previously noted. In an earlier series of cases the incidence of complete retention was about 16 per cent. Obstruction unless to the degree of complete retention usually results in only a moderate amount of residual urine. In this series the amount varied from 30 to 300 cubic centimeters in approximately 66 per cent (Table IV). The size of the gland fails to serve as a criterion of the degree of obstruction (Table V) except that a higher percentage of large glands are productive of complete retention than the smaller glands.

TABLE III—AGE OF PATIENTS AND DEGREE OF ENLARGEMENT OF PROSTATE GLAND DETERMINED IN EIGHT HUNDRED CASES

S m des	G d	G d	G d 3	G d 4	C
40-45		2	1		3
46-50	3	10			13
51-55	1	44	15	2	73
56-60	20	96	55	5	171
61-65	16	103	92	19	232
66-70	16	101	73	15	207
71-75	7	23	26	16	74
76-80	1	8	5	5	9
81-85			2	1	3
Total	75	391	71	63	800

PRE OPERATIVE TREATMENT

Experience has shown that the patient with prostatic obstruction is as a rule a poor subject for immediate operation. It would seem that the patient who has been about his work and who on examination appears to be in good physical condition with satisfactory cardiovascular system and little or no demonstrable renal injury resulting from moderate obstruction and urinary retention should not experience particular hazard in immediate operation. This however is not the case. Some time ago in a review of the relationship of preliminary treatment to mortality rate following prostatectomy I presented data showing that the mortality rate in the apparent relatively preferred surgical risk if operation was performed without preoperative preparation approached very nearly that accompanying prostatectomy after adequate preoperative treatment in the group of cases in which the general condition was poor and there was marked renal insufficiency, infection of the urinary tract and cardiovascular disease. The merits of preliminary treatment in all cases have been definitely established and it may be asserted that prostatectomy should never be performed without a period of preliminary treatment. Drainage of the bladder is of prime importance and unless there are good reasons for cystostomy drainage should

TABLE IV—AMOUNT OF RESIDUAL URINE IN SEVEN HUNDRED AND SIXTY CASES

C b i e t met	Cas	P	t
None	31	4	0
30	79	10	3
60	81	10	6
90	62	9	1
91-150	108	14	
151-300	147	19	3
301-450	42	5	5
451-600	21	2	7
601-700	3		
751-900	3		
901-1050	7		
All urine residual	176	3	1
Total	760		

be established by a permanent indwelling urethral catheter and continued until the cardiovascular renal reserve has been restored to the point of relative safety for operation.

During the last 3 years in the clinic the principle of preliminary treatment in all cases for a minimum of 10 days has been carried out. A period of from 10 to 14 days of urethral catheter drainage in those patients in relatively good condition comprising a group that was formerly operated on without preparation has resulted in marked reduction of mortality rate. Permanent urethral catheter drainage of the bladder is the method of choice for it facilitates the one stage visualized operation. Suprapubic drainage is necessary under the conditions of associated vesical lesions such as stones and diverticula and in those cases of marked renal insufficiency requiring a long period of drainage preliminary to prostatectomy. Intolerance to the urethral catheter likewise occasionally requires suprapubic drainage but in my experience this occurs in only about 6 per cent of the patients. Suprapubic drainage as such provides an excellent method of preparation and insures the greatest safety in the management of patients in poor general condition however that it justifies adoption in all cases is questionable. The disadvantages of inaccurate subsequent prostatectomy places it in disfavor as a method of choice in comparison to urethral catheter drainage with the subsequent one stage visualized operation. During the period of drainage stabilization of renal function occurs with marked improvement in the general condition of the patient who has experienced

TABLE V—AMOUNT OF RESIDUAL URINE AND DEGREE OF ENLARGEMENT OF THE PROSTATE GLAND IN SEVEN HUNDRED AND THIRTY THREE CASES

Cases	Residual Urine (cc)	Enlargement (cc)
1-50	33	80
51-100	4	67
101-150	4	3
151-200	—	3
201-250	—	3
251-300	—	3
301-350	—	3
351-400	—	3
401-450	—	3
451-500	—	3
501-550	—	3
551-600	—	3
601-650	—	3
651-700	—	3
701-750	—	3
751-800	—	3
801-850	—	3
851-900	—	3
901-950	—	3
951-1000	—	3
Total	18	17
	47	6
	—	733

much depletion of organic reserve. In the suprapubic drainage was the method of choice or necessity in the preoperative management in 85 per cent of the patient. In much a suprapubic drainage was required for the patient in postoperative condition and though with complication it is natural that the time between drainage and subsequent prostatectomy should be longer than if the two operations were used generally. It has not seemed wise to consider prostatectomy in any case within a week from the cystostomy. Approximately half of the patients were prostatectomized in interval of a month however the time interval in 1 per cent of the patient was by necessity more than 100 days and in three patients more than a year interval between suprapubic drainage and prostatectomy.

While the general condition of the patient is the important guide to the time at which prostatectomy may be considered the renal function is the most exacting factor in the danger of operation rather than in its safety. The extent of uremia is a guide in determining renal reserve however a constantly low phenolsulphonephthalein return or a persistently high blood urea estimate usually indicates a narrow margin of renal reserve and only under most unusual circumstances may prostatectomy be undertaken with any degree of safety if the phenolsulphonephthalein return is less than 50 per cent or if the stabilization of the blood urea is much more than 50 milligrams for each

TABLE VI—CAUSE OF DEATH IN FIFTY FOUR CASES

Cases	Cause of Death
15	Uremia
1	Phlebitis
0	Embolic
8	Myocardial infarction
5	Septicemia
3	Respiratory distress
1	Shock
1	Asphyxia
1	Other

100 cubic centimeter. Uremia and pyelonephritis still occupy the position of the most important causes of death following the operation and usually produce death when irreparable renal injury has occurred secondary to long standing retention and infection of the urinary tract.

SURGICAL CONSIDERATIONS

Two stage suprapubic prostatectomy is the procedure of choice and necessity under certain circumstances and provides a method of surgical procedure which under such circumstances and in the presence of complications carries the minimal risk. However the one stage visualized operation is gradually becoming more and more the one of choice and when employed in properly selected cases after adequate preoperative preparation is accompanied by a minimal mortality rate and excellent functional result. In this series the one stage operation was performed in 7 per cent of the cases.

Certain phases of the surgical procedure are worthy of repetition and emphasis. Recent change in the types of anesthetic used for operations in this field have exerted a marked influence on postoperative complications and mortality. Ether as a general anesthetic presents the greatest hazard in cases of prostatic obstruction not in its administration for there is a wider margin of safety during ether anesthesia than in that produced by other general anesthetics but in the subsequent renal depression and acute pulmonary complications. The various gas anesthetics have much to commend them however unless skillfully administered they often produce cyanosis when anesthesia is carried to the point of complete relaxation. Lundy has recently called attention to the deleterious effect

TABLE VII—RESULTS OF OPERATION IN SIX HUNDRED AND FIFTY SIX CASES (TWO YEARS OR MORE AFTER OPERATION)

Case	Case	Percent
Practically well	357	54.4
Marked improvement	19	28.8
Slight improvement	86	13.1
No change	24	3.6
Total	656	

of repeated cyanosis. Regional anesthesia which has properly displaced general anesthesia in this field of surgery minimizes postoperative renal depression and pulmonary complications from inhalation.

The visualized one stage operation provides exposure for accuracy in conduct of operation and application of hemostatic measures. Accurate hemostasis is most important. Continued postoperative bleeding rapidly reduces resistance to infection and while few patients under modern surgical methods succumb directly from excessive loss of blood continued bleeding exerts a profound influence on mortality through the subsequent advent of general sepsis or pyelonephritis. The Pilcher bag used in 850 cases has proved a most effective method of hemostasis when utilized with hemostatic control by suture at the vesical neck.

So far as mortality is concerned it is possible to obtain an incredibly low rate for a considerable time and for a considerable number of consecutive cases either through particular good fortune or careful selection of patients denying the benefits of operation to those patients with a narrow margin of cardiovascular renal reserve. Accepting as contra indications to prostatectomy only such conditions as cardiac decompensation, coronary sclerosis with evidence of marked myocardial injury and advanced malignant hypertension operation was performed in 140 consecutive cases after adequate preoperative treatment with but one death. Four deaths occurred however in the next 54 cases so that the mortality rate in the 194 cases in which operation was performed during that year was 2.5 per cent. On the other hand previous to the adoption 3 years ago of the principle of preoperative drainage in all cases 36 per cent of the patients were operated on without preoperative preparation with a mortality rate of 6.6 per cent. A

TABLE VIII—SEXUAL POWER IN SEVEN HUNDRED AND TWO CASES

	Cases	Percent
Normal before and after operation	9	32.6
Poor before and after operation	180	5.6
Normal before poor after operation	196	7.9
Poor before normal after operation	97	13.8

far perspective of mortality rate may be obtained only on the basis of an average over a period of years. The mortality rate in the 1000 cases in this series (for a period of about 8 years) was 5.4 per cent and includes all deaths even though in some instances death was due to conditions apparently not related to the operation. General sepsis, uricemia and pyelonephritis were the most important causes of death. Pulmonary embolism was the cause of death in 8 cases, coronary sclerosis in 2, pneumonia in 3 and bleeding duodenal ulcer in 1 (Table VI).

RESULTS OF OPERATION

As one must depend largely on the patient's statement regarding the symptoms of prostatic obstruction and the amount of disability produced, one must likewise depend on his statement regarding the benefit derived from treatment. The results of prostatectomy are very gratifying, about 85 per cent of patients are completely or almost completely relieved of all symptoms of prostatic disease (Tables VI and VII). A small group of patients experience no change in urinary frequency which in many instances on re-examination has been found due to pre-existing progressive pyelonephritis and infection of the urinary tract. Certainly the incidence of residual urine and the formation of vesical calculus and so forth is small after complete removal of the obstructing gland.

SUMMARY

The point is emphasized that the case of benign prostatic obstruction is largely medical, a surgical condition is present but there are aspects which may best be appreciated by the physician. Only through the combined interest and co-operation of the internist, urologist and surgeon can the patient be operated on with the minimal risk and assurance of the best functional result.

NEUROBLASTOMA OF THE ADRENAL IN YOUNG CHILDREN

B. MARTHA WOILSTEIN, M.D., N. Y. R.

PRIMARY tumor of the adrenal medulla occurring in young children congenital in origin and malignant in course have been known for a long time. They appear in the literature under various names. Thus Virchow (17) in 1864 decided to classify tumors of the adrenal medulla as glomatomata. Marchand (11) in 1891 described a tumor originating from the sympathetic part of the adrenal hilum, and called it which on cross section gave a granular appearance. He also noted the resemblance to round cell sarcoma. Kretz (6) in 1900 suggested that the round cell sarcomata of the adrenal and liver reported in young children originated from the formative cells of the sympathetic system. Lippert (14) in 1901 and Hutchison (5) in 1907 published series of similar tumors under the name of suprarenal sarcoma. It was Wright (10) in 1910 who studied this group of neoplasms collected 8 from the literature and described 4 of his own under the name of neuroblastoma or neuroblastoma of the adrenal medulla. Wright drew attention to the similarity of the morphology and arrangement of the cells and fibrils in the growth to that in theanlage of the adrenal and the sympathetic nervous system at certain period of their development. Landau (5) in 1913 used the name malignant sympathetic blastoma. Wolbach (16) preferred the name neuroblastoma sympathicum to indicate that the embryonal nerve cell composing the tumor belong to the sympathetic nervous system. On the basis of the most recent histological investigation Bailey and Cunningham (1) prefer the name sympathetic blastoma because they point out that not all the cells in the tumor are potentially neuroblastic since some of them may differentiate into chromaffin cells. The sympathetic blastoma is a malignant neoplasm originating from embryonal sympathetic cell of the sympathetic system. While the majority of the reported cases of this type have been found in

the adrenal medulla they may grow from embryonal sympathetic cell or sympathetic coblasts anywhere in the body. Thus tumors not involving the adrenal gland have been reported by Landau (8) from the abdominal sympathetic chain in a girl of 8 months and by Boyd (4) in a boy of 4 years. Martius (11) described one from the cervical sympathetic chain in a boy 1 year old. The interesting case reported by Amichow (1) originated in front of the lumbar spine and invaded the cauda equina. Anderson and Shennan (12) found a neuroblastoma growing in the apical region of the right lung in a girl 1 week old. The case reported by Pick (15) originated from the uterus and Litter's (16) adult case grew from the intestine.

At the Babes Hospital we have accumulated a series of 9 adrenal sympathicoblastomas proved by microscopic study of the tumor at operation or at autopsy. Three cases diagnosed clinically but not confirmed by microscopic study are not included in this series. The 9 neoplasms fall into several distinct groups clinically and anatomically.

The simplest tumor of the series has several points in common with Marchand (11) case briefly recorded in 1880 and minutely described in 1891.

CASE D. K. female 11 years old
 1st. mptms. pt. pl. r. l. failure to gain weight
 Sh. n. l. t. l. th. l. a. b. t. f. f. 7
 k. s. t. h. h. r. l. l. A. t.
 l. h. s. l. l. f. l. d. h. a. l. m. t. l. t. h.
 h. p. l. h. e. m. a. l. r. g. th. n. l. f. a.
 m. a. t. m. b. a. f. l. m. th. l. f. k. l. n. v. r. g. o. n.
 N. u. t. h. k. d. v. a. p. l. l. a. n. l. X. e. m.
 t. n. f. t. h. b. l. m. n. g. k. u. t. h.
 h. l. a. r. f. b. l. n. l. l. h. o. k. l. l.
 A. t. o. p. y. t. h. c. t. u. f. l. t. h. f. l. t.
 b. e. l. r. n. h. p. m. n. a. f. l. f. t. l. n. l. n. t. l.
 g. l. o. u. l. a. r. t. m. m. g. a. l. 4. t. u. m. t. r.
 l. n. t. t. m. o. o. t. h. l. l. t. t. t. l. n.
 the t. l. m. l. l. l. t. b. th. l. f.
 c. e. l. l. t. a. t. t. m. l. m. t. r.
 th. r. c. u. p. l. t. h. l. h. l. f. f. t. h.
 g. l. u. p. p. h. l. f. n. r. m. a. l. l. m. n. s. n.
 O. g. w. t. h. h. a. l. g. u. l. l. y. g. h.
 tr. a. n. a. n. c. e. l. e. f. t. k. i. n. y. m. d.

$5\frac{1}{2}$ by 2 centimeters. Its upper half was indented to receive the globular adrenal tumor. The right kidney measured 5 by 3 centimeters and was capped by a normal adrenal measuring 2 by 1 centimeter (Fig. 1). Microscopic examination showed the tumor to be divided into irregular alveoli by thin fibrous connective tissue septa carrying blood vessels. The alveoli were filled with masses of small round cells with deeply staining nuclei and little cytoplasm. Some mitoses were present. Between the round cells lay bundles of delicate fibrils which took the eosin stain but not the special collagen fibroglia or neuroglia stains of Mallory (10) (Fig. 2). There were a number of pseudorosettes first described by Kuester (7) where the cells were arranged around a central mass of fibrils (Fig. 3). The adrenal medulla beyond the tumor was unusually rich in round cells with hyperchromatic nuclei. The cortex of the compressed adrenal tissue surrounding the tumor was normal in arrangement but very narrow (Fig. 4). The kidney showed no involvement in the neoplastic process. No metastases were present in any organ.

Slightly more complicated were the cases of two young infants admitted to the hospital with enlarged livers in which nodules were palpable. The younger was only 3 weeks old and the mother had noticed the large abdomen during the third week of life.

CASE 2. The infant was born at term after a normal labor. The diagnosis on admission lay between birth sepsis with peritonitis and neoplasm of the liver. The child died on the second day in the hospital. At autopsy the liver weighed 600 grams; it was filled with metastatic tumor nodules, yellowish in color, with a central zone of hemorrhage (Fig. 4). The primary growth was in the right adrenal forming a globular mass $4\frac{1}{2}$ by $3\frac{1}{2}$ centimeters in diameter, cupping the right kidney. On the upper border of the tumor a small compressed piece of adrenal remained. This is a characteristic feature of the sympathicoblastomata. The growth was red, soft and haemorrhagic. The left kidney and adrenal were both normal. Microscopic examination showed that the primary tumor was composed of round cells aggregated into masses with bundles of eosin staining delicate fibrils ramifying between and around the cell groups. The small cells had hyperchromatic nuclei. There was a small number of larger cells with nuclei vesicular in character. A section made through the part of the adrenal gland attached to the upper border of the tumor showed the cortical layers maintained in normal conformation but at one point the tumor cells had invaded the reticular zone. The entire medulla was transformed into the tumor. Pseudorosettes were present. Sections of the liver metastases showed a more distinctly alveolar arrangement with cells similar to those in the primary tumor but fewer fibrils and larger vessels. Landau (8) has pointed out that the more

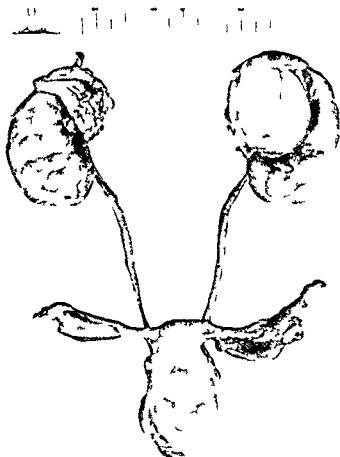


Fig. 1. Female infant 16 weeks old. Showing sympathicoblastoma of the left adrenal cupping the kidney and an uninvolved portion of the adrenal. There were no metastases.

rapidly growing portion of these growths are less rich in fibrils. No other organs showed metastases and the abdominal lymph nodes were not enlarged.

CASE 3. A male infant 4 months old was brought to the dispensary for rhinitis. The liver was found to extend finger breadths below the costal margin. Five months later he was admitted to the hospital with an acute bronchopneumonia. The mother said that she had noticed distention of the abdomen the day before. At the time of admission the lower border of the liver reached the iliac crest. The child died 9 hours later and at autopsy the liver weighed 827 grams. The whole organ was studded with round nodules varying in size from 2 millimeters to $3\frac{1}{2}$ centimeters in diameter. Some of the smaller nodules were gray but the larger ones were soft with a central zone of hemorrhage. Little normal liver substance was left. The right kidney weighed 3 grams and was normal in size. The right adrenal weighed 2 grams and surmounted the kidney as usual. The left kidney was 7 centimeters long and was capped by a globular mass 6 by $5\frac{1}{2}$ centimeters in diameter showing on its upper pole a small flattened portion of adrenal only 1 to 3 millimeters thick. The tumor and kidney weighed 84 grams (Fig. 5). Microscopic examination gave the characteristic picture of sympathicoblastoma with pseudorosette formation.



FIG. 5. Male infant 9 months old. Adrenal sympathicoblastoma cupping the kidney. The kidney and tumor weighed 84 grams.

a boy 3½ years old who died during the operative attempt to remove the orange sized tumor in the left adrenal which had metastasized into the bones of the skull the ribs and the mesenteric retroperitoneal mediastinal cervical and inguinal lymph nodes.

CASE 5. A similar but less generalized case was that of a boy of 18 months who was admitted with a history of having been pale for 2½ months with irritability and occasional fever. He had a soft irregular nodule behind the left ear 5 by 4 centimeters in diameter. In the left upper quadrant and across the lower portion of the abdomen there was a palpable hard mass which was not tender. Coils of intestine were felt in front of it. The liver extended 2 centimeters below the costal margin and the spleen 3 centimeters. There was a nodule over the middle portion of the left clavicle 4 by centimeters in diameter. The right knee was held rigidly in a slightly flexed position. It was swollen and tender and measured 1 centimeter more than did the left knee. Palpable lymph nodes were found in the suboccipital posterior cervical axillary and right inguinal groups. The child died 3 days after admission. At autopsy the primary tumor 9 centimeters long with a circumference of 27 centimeters was found in the left adrenal (Fig. 8). Just behind the pancreas a mass 3 centimeters in diameter surrounded the aorta. Metastatic nodules were found in the liver the retroperitoneal lymph nodes the



FIG. 6. The same case as that shown in Fig. 5. Photomicrograph of liver metastas showing the penetration of sympathetic blast between liver cell columns and between small groups of liver cells.

twelfth left rib and the left kidney pelvis. Microscopic examination showed that the primary tumor and the mass in front of the aorta were both sympathicoblastomata which had metastasized into the liver bones and lymph nodes. The mass in front of the aorta was interesting and was found in two other cases in our series. It evidently originated from the sympathetic ganglia normally developing in that position.

A tumor originating in this region and not involving the adrenals has been reported by Landau (8) in a girl 8 months of age. In our case the prevertebral tumor and the adrenal tumor each represented a primary focus. In Wahls case (18) a peri aortic mass originated from the celiac plexus.

There were two cases in the series in which an inoperable retroperitoneal mass was found on exploratory incision and the origin of the neoplasm could not be determined at operation. Both the children were about 2 years of age.

CASE 6. The older was a girl of 26 months who had been born at term and had been bottle fed. The mother said that she had always had a big high stomach and brought her to the hospital because 3 weeks before she had felt a lump in the baby's left side. This mass was found to be inoperable and the child died on the sixth day after abdominal exploration. At autopsy a retroperitoneal tumor



Fig. 7. Left kidney, right kidney, and tumor. The tumor is a large, irregular mass, likely a neoplasm, shown in cross-section. The kidneys are shown in longitudinal section, revealing internal structures.

found in the kidney. The large portion of the left kidney was removed. The right kidney was also removed. The tumor was a large, irregular mass, likely a neoplasm, shown in cross-section. The kidneys are shown in longitudinal section, revealing internal structures.

In this instance it is difficult to say whether the prevertebral mass is evidently originating

from abdominal sympathetic ganglia or the growth in the left adrenal was the primary focus and the neoplasm probably originated from two foci. Wahl interpreted his case as composed of three primary tumor.

CASE The other case is a boy 3 months old who was the 1st child. He had been born full term for 4 months and had a normal birth weight of 3.5 kg. For 3 weeks before admission he had complained of abdominal pain and the mother said that the abdomen was growing larger. At the time of admission on the 1st day of life the child was ill. The color was pale. The abdomen was dull in the flanks and unrelieved by the large mass. As the child thought to be attacked to the liver jaundice developed. The stool became clay color. At postmortem a large mass was found to be protruding on the surface of the liver and causing distortion of the gall bladder. The tumor could not be removed and the child died 14 days later. Autopsy revealed a large retroperitoneal tumor involving both adrenal glands. The completion of the abdominal cavity was completed. The right kidney was embedded in the mass but the left one was free. The tumor was almost globular and composed of several lobes which were firm and yellowish white on section interspersed with larger areas of hemorrhage. The right kidney was placed in a normal position. The tumor was on the upper pole and the border. Within its substance however there was no metastasis. The left kidney was normal in size and structure. No metastasis was found. The pancreas was compressed by the tumor and narrowed to half its normal diameter but its substance contained no nodules. The retroperitoneal nodes were all enlarged and some of the mesenteric vessels. The spleen in its normal position showed no lesion. Microscopic examination showed the characteristic structure of sympatheticoblastoma with pseudopapillary formation (Fig. 8).

There were two cases which were more complicated in structure than 6 of the 7 other and which histologically were both sympatheticoblastoma and ganglioneuroma. The older of these two children was the oldest of our series being nearly 3 years of age.

CASE 8 A boy born at term and born full term. When he was 8 months old the mother noticed that the right side of the abdomen was hard. He looked at 15 months the child seemed quite well but he brought to the hospital at the age of nearly 3 years because of the lump in the side and limp. The mass extended from the lower thorax to the upper abdomen. Laparotomy was performed and the right kidney was found to be normal. The tumor was removed. The child was weighed 680 g. and looked like a normal child. The child had a normal growth and development.

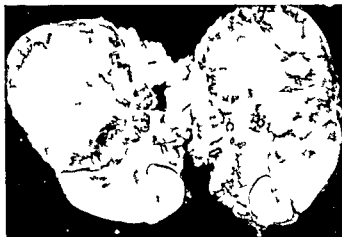


Fig. 8. Male child, 8 months old. Cross section showing the variegated appearance of the adrenal sympathicoblastoma and part of the pre-arterial mass.

of the right kidney, which was entirely separate from the tumor and normal in shape and structure. The tumor was 18 centimeters long and 11 centimeters wide and its circumferences were 37 and 27 centimeters respectively. On section the lower part of the tumor was found to be red mottled soft areolar in appearance showing many yellow points of calcification, some so hard that they grated against the knife. The upper third was white areolar and firm and contrasted with the softer embryonal appearance of the lower two thirds. The microscopic diagnosis was ganglioneuroma of the adrenal. The child recovered from the operation and could not be traced for final report.

CASE 9. The other patient was a boy, 15 months old, whose parents had been treated for syphilis 5 years before his birth. There had been 11 pregnancies and only 3 children were alive. The patient was born at term and was nursed for 9 months. He was brought to the dispensary because he was irritable, sleepless, and underweight. His Wassermann reaction was negative. A hard globular mass was felt in the abdomen in the left upper quadrant. The liver was palpable. Axillary, inguinal, and posterior cervical lymph nodes were palpable. The spleen was felt above the mass and reached only to the costal border. The urine was negative; the blood showed a moderate anemia. Operation was performed by Dr. Bolling and a large mass was removed with the diagnosis of adrenal neoplasm. Dr. Bolling's notes read as follows: "An irregular nodular mass lying above but not adherent to the left kidney, retroperitoneal. There were no enlarged glands nor was there any evidence of extracapsular growth beyond the midline. The peritoneum lateral to the descending colon was incised and the tumor delivered with considerable difficulty, partly by blunt dissection and partly by isolating adhering areas containing bleeding vessels and cutting between ligatures. There was no connection with the kidney. After removal of the tumor, no attempt was made to suture the incision in the peritoneum. The wound



Fig. 9. Female child, 3 years old. Showing an inoperable lobulated, penetrated mass and large globular sympathicoblastoma in the left adrenal.

was closed in layers with three retention sutures. The child's condition was fair throughout.

The specimen was an elliptical mass weighing 140 grams. It measured 6 by 7 by 3 1/2 centimeters. The surface was irregularly nodular and the capsule roughened but intact. Adherent to the posterior surface was a much compressed piece of adrenal gland 5 centimeters long, 2 centimeters wide and 2 millimeters thick (Fig. 11). It was possible to dissect this portion of adrenal free so that both surfaces were seen to be flattened and on section the cortex and medulla were only a line in thickness. Its upper end merged into the tumor and could not be separated from it. The cut surface showed that the neoplasm was composed of small round lobules varying in size from 3 millimeters to 1 centimeter in width. These were either pink or dark red in color with yellow areas of inspissated blood. At the upper pole of the tumor there was a pink, even smooth dense area 2 centimeters wide and 3/4 centimeters long which had the smooth appearance of a sarcoma, quite in contrast to the variegated appearance of the rest of the growth.

Microscopic examination of a section from the upper pole of the tumor including the dense (pink) area showed that the structure of the soft central portion differed from that of the periphery. In the former were masses of cells varying in size and shape, arranged in smaller and larger alveoli bounded by cellular fibrous tissue. The cells were partly round and small, partly larger and multinucleated and partly triangular in shape; some of them had nuclei at either pole and none showed mitotic figure. Between the cells were masses of delicate fibrils, some of which were connected with the cells. Definite pseudorosettes were seen. The blood vessels were small and numerous, carried by the connective tissue between the alveoli. In the dense pink layer at the periphery of the tumor, large cells like adult ganglion cells were numerous (Fig. 12) while mass of nerve fibers having a definite neurolemma formed

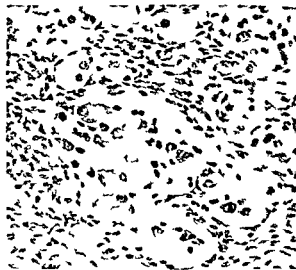


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I l v r l k l l Th g a l l l
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Ichmann (10) reported the case of a boy who was well 6 months after operation performed when he was 11 months old. The child operated upon by Dr. Bolling is the only one recorded who was alive one year after operation.

In our group of 14 cases of neuroblastoma of the adrenal medulla there were 3 boys and 6 girls. The tumor involved the left adrenal in 4 cases, the right in 4 and both adrenals once. The age of the children varied from 1 week to 14 months, being under the age of 1 year in the 1st and 2nd years in the third year. There are 3 different types in this series according to the location of the primary tumor and its metastases. Thus we have first the simplest case of the series in which a small nodule was found in the left adrenal leaving the rest of the organ in an apparently normal condition and forming no metastases. This tumor showed microscopically the most typical and exquisite



I l l C e g

structure of embryonal sympathetic cell and fibril according to Wright's classical picture.

The next type is illustrated by 2 cases both in young infants, 3 weeks and 9 months old respectively and both boys. The younger child showed the tumor on the right side, the older one on the left side. Both developed metastases in the liver, enlargement becoming so great that it was the outstanding symptom. No other metastases were present. While the case of this type occurs most often in young infants, Wolbach and Morse (19) have reported a case in a boy 4 years old.

The third type conforms to what has been known as the Hutchins on type (5) of round cell sarcoma of the adrenal. It is represented in our series by 1 case, 1 boy and 1 girl, 18 months and 31 months old respectively. In the latter it was the right adrenal which was affected while in the former the left side was the seat of the primary growth. Both showed metastases over a much wider area involving bones of the skull, the ribs, the pelvis, the clavicle and the liver and in the case of the girl the dura mater. The liver was involved to a much less extent than was the case in the second group. The children thus affected are more often in the second or third year of life. In spite of the differentiation of part of the growth into a ganglioneuroma, metastases of sympathicoblastoma were present when the child was first seen.

In the fourth group there are again 2 patients a boy of 3 months and a girl of 6 months. In the boy both adrenals were affected in the girl only the left. Both of these cases were characterized by an inoperable tumor lying in front of the vertebral column between the adrenals and kidney making a mass from which kidneys adrenals and nodes had to be painstakingly separated and dissected. In both children the prevertebral mass represented a second tumor focus. Lindau's (8) case of an 8 months old girl had a neuroblastoma primary in the retroperitoneal lumbar region which metastasized into the liver. In our case there was a metastasis in the kidney on the same side as the large tumor in the adrenal. The right renal tumor compressed the liver but did not invade it and jaundice developed because of the mechanical effect of the tumor on the common duct.

The final group was the most interesting of all and comprised 2 tumors 1 from the right adrenal of a 3 year old boy and the other from the left adrenal of a boy 15 months old. Both were removed by operation and the younger child is alive 1 year and 5 months later. It is characteristic of both of these tumors that they were entirely separate from the kidney which was not compressed or deformed by the growth. In all the 7 other cases the upper pole of the kidney was cupped to receive the globular adrenal neoplasm. In the last 2 cases the neoplasm was also globular but it was entirely separate from the kidney and readily removable without it. In both cases a small much compressed portion of the adrenal remained on the upper pole of the neoplasm and this portion of the adrenal gave a normal histological appearance. It is characteristic of all the adrenal tumors that their cut section has a granular irregular alveolar appearance described by Wahl (18) as variegated and unlike the soft brain like consistency of the embryonal kidney sarcomata.

The tumors of the fifth group showed two distinct portions on section. One was pale pink very firm and even in appearance while the other had the granular roughened appearance characteristic of all adrenal neuro-



Fig. 11. Male child 15 months old. The adrenal sympathicoblastoma and ganglioneuroma was removed by Dr. Bollin. 11 months child is alive 1 year later.

blastomata. Microscopic examination showed that the firmer portion was characterized by the presence of many large adult nerve cells with distinct nuclei and nucleoli while the other portion of the tumor was composed almost entirely of the embryonal type of sympathetic nerve cells with numerous fibrils representing axon cylinders. Chromaffin cells were not present and both tumors were classified as neuroblastoma and ganglioneuroma. Martius tumor of the cervical sympathetic while chiefly a neuroblastoma presented one firm nodule which was a ganglioneuroma. Wahl's tumor in a girl $\frac{1}{2}$ years old contained areas of neuroblastoma ganglioneuroma and chromaffin tumor all being variously differentiated stages of the same embryonal pluripotential cell.

Clinically the most rapidly fatal cases are those which present the large liver as the main symptom. The tumors which metastasize to the bones often present swelling and discoloration of the lids of one or both eyes as the first symptom the adrenal primary tumor being found on abdominal palpation. The sympathicoblastomata originating in the adrenals and in the abdominal sympathetic ganglia resulting in a prevertebral mass

between the adrenals and kidneys without metastases cannot be diagnosed with any degree of certainty. The rare sympathicoblastomata of the adrenal which are not adherent to the kidney and show areas of differentiated ganglion cell may be operable because they apparently do not metastasize early. They contain areas of neuroganglionoma as well as of sympathicoblastoma and it is the latter only apparently which form metastases.

CONCLUSIONS

In a series of 9 sympathicoblastomata of the adrenal medulla in young children, contained areas of ganglioneuroma in parts of the tumor. One such tumor metastasized very generally to the bones, dura and liver. The other were removed by operation before metastasis occurred. Both children recovered from the operation and one is alive a year and 5 months afterward, the only one recorded to survive so long.

In 7 of the 9 the tumor proved inoperable when first diagnosed.

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physical and chemical changes in the blood. Among the changes that may occur after the intravenous injection of such colloid and gum mastic and various hypertonic solutions of crytalloid in the concentrations that have been used in clinical work are hemagglutination, hemolysis, darkening and rapid sedimentation of the blood, lowering of the hydrogen ion concentration, increase of lactic acid and a diminution in carbon dioxide content of the blood. Of obvious striking importance were changes observed in the hemoglobin and red blood corpuscle followed sometime by the occurrence of minute pulmonary emboli with capillary thrombosis and extracapillary hemorrhage and edema. Pulse, blood pressure and respiration changes were also apparent. More recently Appleman (11) has compared the effect of 6 per cent acacia on the viscosity of oxalated blood and sedimentation of corpuscles *in vitro* with the change in these physical factors of the blood after intravenous injection in rabbit. He confirms alteration in the blood as found by Hanzlik. The viscosity of the blood increased. At times the blood was so thick that its viscosity could not be measured. The ripidity of corpuscular sedimentation was greatly increased. Control solution of sodium chloride however produced no such effect. Finally Hanzlik and Kerner have shown that many a cent among which was acacia in the concentration which has been used in the treatment of shock and hemorrhage agglutinated red blood cells *in vitro* in solution as basis for preliminary embolic and other histological evidence of lung injury. Doster and Whipple (17) have noted that intravenous injection of acacia delayed return of the fibrin content of the blood to its normal value and that clotting was delayed or prevented. The latter factor of importance when contemplating the use of gum acacia solutions in uncontrolled hemorrhage. Cassell (19) warns that the greatest care should be used in the use of blood substitutes in man. In his experience this effect with a fall in blood pressure was not an unusual occurrence.

CLINICAL FINDINGS IN SHOCK

In a recent paper Fisher (16) has advocated the use of glucose and insulin in the

treatment of shock. His conception of shock and its rational treatment is based upon the following statement: "Our conception of shock is that in this state an internal asphyxia and acidosis with oxidation processes held in check or abeyance result in a state of exhaustion. I personally believe that this state is primarily caused by a sudden derangement of the central nervous system. Whether the two conceptions are correct or not, any method promoting combustion and oxidation and at the same time furnishing heat energy should be effective in combating shock. Fisher surmises that insulin might serve to increase the rate of oxidation of glucose in the tissue and aid in supplying carbohydrate or food and oxygen in some manner to the injured and anoxic cell—thus aiding in combating the injurious effects of the toxin which is thought to produce shock. After a review of the literature concerning our present knowledge of the fate of glucose after insulin injection no reason was obvious to us why glucose insulin should act more beneficially in shock than a hypertonic solution of the crytalloid glucose without the addition of insulin. Fisher mentions his case of shock treated successfully with glucose and insulin and records in detail 5 typical cases. Two of these cases he regarded as toxic or septic shock. We wonder if such cases should be classified with traumatic shock since they present factors not found in this condition."

In an effort to aid in establishing the true value of glucose and insulin in the treatment of traumatic shock we have carried out a series of experiments upon dogs.

EXPERIMENTAL RESULTS

Each dog was anesthetized with ether. After the first few minutes of anesthesia very little ether was required to keep the animal quiet. The carotid artery was connected with a mercury manometer and the blood pressure readings were recorded on kymograph paper. Shock was produced by hammering the thigh muscle of one leg, followed by occlusion of the artery until the blood pressure fell below 50 millimeters of mercury with a definite tendency for the fall to continue. After this state was produced treatment was begun.

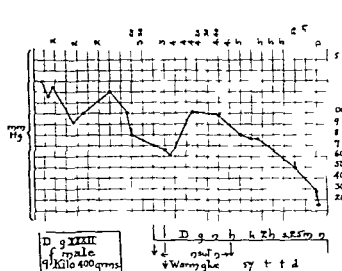


Fig. 1. Chart showing the blood pressure changes in experimental shock treated with glucose and insulin.

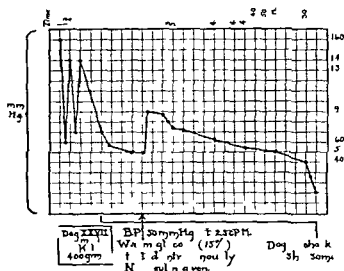


FIG. 2 Chart showing the blood pressure changes in experimental shock treated with glucose only

Fourteen of the dogs were treated with glucose and insulin (Lilly). The latter was used in a dosage of approximately 1 unit of insulin for every grams of glucose given. The insulin was given subcutaneously before the introduction of the glucose in some animals and in others 5 to 30 minutes after the glucose was started. In a few experiments the insulin was given very slowly with the glucose by the intravenous method.

In all but one of the dogs there was a rise in the blood pressure almost immediately following the administration of the hypertonic solution. The usual response was a rise to 80 or 90 millimeters of mercury. As a rule this level was maintained from 15 to 30 minutes after which the pressure slowly fell and usually continued to fall steadily until the animal died from 1 to 4 hours after treatment was begun. In no case did an animal recover completely although one recovered a blood pressure of 100 and lived from 2 45 p m until midnight or 6 hours and 15 minutes.

Six animals were treated with glucose alone to control the glucose in ulin treatment. The blood pressure reading in this series differed very little from those in the series receiving the ulin.

Shock was produced in the same manner in 17 dogs used as controls and progress was noted until death. The rapid fall in blood pressure with a continued low pressure until the end of the experiments corresponded very

closely to the changes in blood pressure of the animals treated. Death occurred from 1/2 to 1 hour earlier than in the treated series. The transitory rise in pressure after the glucose was given of course was absent in the controls.

Finally as further controls 2 dogs were treated with 15 per cent glucose insulin and 15 per cent sodium chloride solution. In one animal the glucose insulin was given until the blood pressure fell to a critical level at which time the sodium chloride solution was substituted. In the other animal the procedure was reversed. The change from one crystalloid solution to another gave a slight temporary rise in blood pressure for a few minutes (a rise of about 10 millimeters of mercury) after which time the manometer reading fell as before the change of solutions.

In no instance was any evidence noted that the addition of insulin in any way caused any specific aid that could be determined by change in blood pressure or general condition of the animal. Glucose alone in 6 animals acted as favorably as the glucose insulin combination. The hypertonic sodium chloride solution temporarily elevated the blood pressure similar to the glucose or glucose insulin solution.

Several times during the production of the shock state the blood pressure would spontaneously recover after being below 70 millimeters of mercury from 10 to 20 minutes. Thus it is to be noted that any treatment

instituted before the tendency toward a falling pressure was definitely established might appear to be of value.

In two dogs intravenous 15 per cent glucose given at the rate of 5 cubic centimeter per minute apparently caused a change in the hemoglobin. The blood withdrawn after death in the case was chocolate colored. This seemed to us sufficient evidence to warn against giving very rapidly glucose solution in this strength.

SUMMARY

1 In the interpretation of shock treatment it must be remembered that mild cases often recover either with or without the use of the common intravenous solutions. Before an estimate is made as to the value of any special method it must be definitely determined that the condition dealt with is really shock.

Hypertonic solutions of crytalloids have not been used with complete success in the past in the treatment of well developed shock. Recently evidence is accumulating that intravenous therapy with hypertonic solutions of crystalloid unless introduced with the greatest care may be actually harmful.

3 From the experimental standpoint the glucose insulin treatment of shock recently advocated by Fisher seems to be no more beneficial than treatment with a hypertonic solution of glucose or sodium chloride.

4 Further studies should be made to learn if possible whether a patient in the true shock state can utilize glucose with insulin as do normal individual or patients suffering with other diseases.

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DEFENSIVE FACTORS IN CARCINOMA OF THE BREAST¹BY I AUL G FLOTHOW M D F OCHSITER MINNESOTA
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UNTIL recently it has been practically impossible to give even a fairly accurate prognosis in any form of malignant disease. A consideration of the defense reaction against carcinoma led MacCarty in 1910 to observe the presence of lymphocytic infiltration, fibrosis and hyalinization around carcinoma cells in the breast and also the differentiation of these cells. He later applied the presence or absence of these factors in prognosticating the postoperative length of life. On this basis Broders in 1919 made a fairly accurate prognosis possible in cases of epithelioma, his prognostic data being based on a system of grading the degree of malignancy of these growths according to the relative degree of differentiation present.

LITERATURE

Most of the literature on the subject of defensive factors in carcinoma of the breast is the result of the work of MacCarty and Broders. In 1921 Sistrunk and MacCarty published a paper based on the study of 18 breasts which had been radically removed for carcinoma. The study was both pathological and clinical. They found that the greatest combined factors in longevity were cellular differentiation and hyalinization and that cellular differentiation, hyalinization and fibrosis are the greatest single factors.

Again in 1922 MacCarty in a further study stated that when any of the factors are present postoperative life is increased and increased most when differentiation and hyalinization are present. He stated that the uniform consistency of increased length of postoperative life in the presence of the defensive factors suggests that they play a significant role as a part of the natural defensive mechanism against carcinoma.

Later in 1922 MacCarty studied 9 cases of carcinoma of the breast in which death had occurred. He found that in the presence of fibrosis postoperative life was increased 34 per cent and 40 per cent in the presence of

hyalinization and that when both were present postoperative life was increased 56 per cent.

In 1924 in studying the prognostic value of the four factors he found that whenever the factors are present the average length of life is greater than when they are absent and that this is true of all four factors. He also found that the variation in the frequency of the presence of the factors in different organs suggests that the defense mechanism probably acts differently in different organs.

MATERIAL AND METHOD

This paper is based on the study of 300 breasts which had been radically removed because of carcinoma. For various reasons only 22 were suitable for inclusion in the statistics. I examined every gross specimen and cut blocks from carcinomatous areas for microscopic study. All of the data have been checked by questionnaires. The living patients have been alive from 5 to 10 years without any evidence of recurrence. In all of the cases studied in which the patient died death occurred within 5 years of the operation and in every case it was due to recurrence or metastasis. The cases were divided into the following groups: (1) those cases in which the axillary lymph nodes were involved the patient being alive after 5 years with no evidence of recurrence or metastasis and (2) those in which the lymph nodes were not involved but death occurred within 5 years. These two groups were studied comparatively in order to determine the relative frequency of the factors in these two extremes. For comparison the following groups were also studied: (1) those cases in which the lymph nodes were involved but death occurred within 5 years and (2) those in which there was no involvement of lymph nodes and the patient is living without evidence of recurrence or metastasis.

Throughout this paper all references to involvement of lymph nodes refer to findings



0 Diff ti ti



1 Diff ti ti



2 Diff ti ti



3 Diff ti ti

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at the time of operation. When the number of years is stated it indicates the interval since operation.

It is well known that in many cases of carcinoma of the breast in which lymph nodes were found involved at operation the patient lives many years after without any sign of recurrence or metastasis. It is equally well known that in many cases in which only a small localized carcinoma is found without involvement of lymph nodes or evidence of metastasis the patient dies within a few months. It has been my aim in this study to find out if possible why this should be true. A clue to the answer may be discovered in MacCarthy's work. If it is true that there is a definite defense mechanism then it should further be true that this defense mechanism should be well developed in those patients who recover in spite of involvement of lymph nodes and that on the other hand cases of fatal carcinoma in which the lymph nodes were free should be characterized by a poorly developed defense mechanism.

The defensive factors dealt with in this study are the same as those observed by MacCarthy, namely differentiation, fibrosis, hyalinization and lymphocytic infiltration and the same definitions for the terms are used.

There is some doubt as to the correct position which cellular differentiation should occupy. It may be an inherent characteristic of the growth itself or it may be due to factors in the surrounding tissues which allow differentiation. At first thought cellular differentiation might naturally be considered as a characteristic of the growth and not connected with nature's defense, but this is apparently not the case. Differentiation of cells in nature is the result of adaptation to favorable environment. It is possible that this is also the case with malignant cells. It is thought that this favorable environment is the property of the organism rather than of the cell itself and for this reason differentiation is placed among the body's defense factors. However it is considered to be an index of the defensive mechanism rather than a specific defensive factor.

The microscopic sections were divided into three groups: those in which differentiation was absent or minimal; those in which the tendency to differentiate was distinct but not marked; and those in which the tendency to differentiate was marked (Fig. 1). Before the results were consolidated Groups 2 and 3 were combined so that the classification was based merely on the presence or absence of cellular differentiation. It is felt that this must play a very definite part and that a growth which is well differentiated should support a better prognosis than one which is not.

There was a distinct tendency to differentiate in about 65 per cent of all cases. The higher the degree of differentiation the more the growth resembled normal gland. In highly differentiated growths it was quite commonly found that none of the other defense factors was present (Figs. 2 and 3).

In the study of fibrosis the main difficulty was in determining in just what case fibrosis should be called a factor of defense and when it should not. If the presence of fibrous

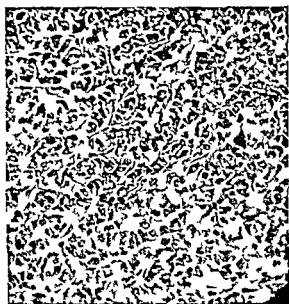


Fig 2 An entirely undifferentiated growth with no defensive factors present

tissue *per se* were to be taken as a positive criterion fibrosis would be present in every case since there is a certain variable amount of fibrous tissue present in every case. In the normal fibrous tissue the fibrils present a characteristic interlacing pattern. Fibrosis due to malignancy however is in much more intimate relation with the cells. The fibrils form a barrier around the masses of cells which is quite different from the arrangement in normal fibrosis. The same question of degree was met with here and dealt with just as in the case of differentiation (Fig 4).

The same statements made in regard to fibrosis are applicable to hyalinization since hyalin develops from fibrous tissue. When hyalinization is marked there is little pure fibrosis since the former is merely hyalinized fibrous tissue. Of all the factors hyalinization is found in the smallest percentage of cases probably because it is the last factor to appear. It was present in only about 30 per cent of the cases. Because of the firmness which characterizes it hyalinization is the most effective of the tissue factors since it constitutes a practically impossible barrier to the advance of malignant cells.

Lymphocytic infiltration is the least important factor however it is the first to appear. It is characterized by a dense wall of small lymphocytes intimately surrounding



Fig 3 Highly differentiated tumors. The cells are of a much more mature type than those in Figure 2. Nucleoli are not prominent and cells are placed in definite acinar groups. Here also there is very little defense reaction.

the cancer cells which may be many cells in thickness (Fig 5).

It was frequently found that when the degree of cellular differentiation was very high there was little if any other defensive reaction. Frequently one factor such as fibrosis or hyalinization was also present to a marked degree while no other factors were present. The degree to which any factor is present undoubtedly plays an important part but as it was difficult to evaluate it it is not included in the statistics.

DATA

In 88 cases the lymph nodes were involved and the patient lived more than 5 years without recurrence or metastasis. In 20 of these cases (3 per cent) all factors were present, in 87 (98.8 per cent) one or more usually more factors were present. In only 1 case were all of the factors absent. In this group as a whole considering four factors for every case as 100 per cent the percentage of factors present was 70 and the percentage of



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I t lly k p f ll h l l
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factor absent was 0. This gave an average of about three of the four factors present in each case.

In 33 cases the gland were free from involvement but the patient died (Group 1). In 11 cases (33 per cent) none of the factors was present. In only one case were all four factors present. Taking this group as a whole 73.5 per cent of the factors were absent and only 6.5 per cent were present. This was an average of only one factor for each case, whereas in the former group there was an average of three (Table I) as exemplified in each tumor that illustrated in Figure 6.

Early in this paper it was stated that if the so-called defensive factors were of any value it would be shown in the 2 groups. It was anticipated that in case such as those in Group 1 the factor should be well defined and that in such cases as those in Group 2 the factor should be poorly defined. Analyzing Table I, however, that this is very definitely the case.

Comparison of the total incidence of the factors in the two groups shows that the difference in minimum was almost three times as marked in Group 1. In Group 1 all four factors were present in 1 per cent or about one fourth of the cases while in Group 2 3 per cent of the cases or only 1 case in the 33 had all four factors present.

In Group 1 only 1 per cent of the cases were there no factor present while in Group

TABLE I—COMPARISON OF GROUPS 1 AND 2

	Lymph	Fib	Hyal	Imph	Def
	(88)	(33)	(33)	(33)	(33)
Cell	1	1	1	1	1
Cell	1	1	1	1	1
Fib	1	1	1	1	1
Hyal	1	1	1	1	1
Imph	1	1	1	1	1
Lymph	1	1	1	1	1
All	1	1	1	1	1
Tumor	1	1	1	1	1
Tumor	1	1	1	1	1

all factors were absent in 33 per cent. In Group 1 there were defensive factors in practically every case while in Group 2 there was absolutely no defense reaction in one third of the cases.

On further analysis of Table I it will be seen that cellular differentiation was about three times as common in Group 1 as in Group 2 being present in the former in 86.5 per cent of the cases and in the latter in only 33 per cent. Fibrosis was present in about the same ratio 86.5 per cent in Group 1 and 36 per cent in Group 2. The preponderance of hyalinization in Group 1 is even more marked; it was present in 53 per cent of the cases in Group 1 but in only 9 in Group 2. Lymphocytic infiltration was twice as common in Group 1—55 to 27 per cent. Not only were the factors as a whole much more common in Group 1 but each individual factor was much more common in Group 1 than in Group 2.

Fifty cases were studied in which the lymph nodes were free and the patients were still alive (Group 3). This group is not very distinctive as in view of the early removal of the carcinoma the prognosis is should be fairly good irrespective of the presence or absence of the factors. In 6 cases (12 per cent) all the factors were present. In 6 cases (12 per cent) all were absent. In the entire group 61.5 per cent of the factors were present and 38.5 per cent were absent.

Fifty-one cases were studied in which the lymph nodes were involved and the patients were dead (Group 4). This group also is not very distinctive as the involvement of lymph nodes with or without the defensive



FIG. 5. Shows the lymphocytic infiltration around the cancer cell.



FIG. 6. Three factors are present: hyalinization and fibrosis are hyalinized in upper half of the field and lymphocytic infiltration in lower left.

factors generally entailed a poor prognosis. Of this group in 4 per cent no defensive factors were present and in 4 per cent all four factors were found. In this group as a whole 61 per cent of factors were absent and 38.7 per cent were present. Even here there was a marked preponderance of missing factors.

SUMMARY

Of the 300 specimens of carcinoma of the breast which were studied for various reasons only 22 were suitable for inclusion in the statistics. The study was confined to the four defensive factors: cellular differentiation, fibrosis, hyalinization and lymphocytic infiltration. The study was undertaken with the idea of proving or disproving their defensive nature. They were found to play a distinct part in retarding the growth and spread of carcinoma. The various factors

are discussed individually and observations on their characteristics are made.

In the 85 cases in Group 1 (the cases in which lymph nodes were involved but the patient was living more than 5 years after operation) 70 per cent of the defensive factors (an average of approximately three of four factors) were present. In 23 per cent of the cases all factors were present. In the 35 cases in Group 2 (the cases in which the lymph nodes were free but the patient had died within 5 years) only 6 per cent of the factors were present, an average of only one of the four in each case. In 33 per cent of the cases none of the factors was present and in only 1 case were all the factors present. There was also a marked preponderance of the individual factors present in Group 1, most marked in the case of hyalinization which was present in 55 per cent of the cases in Group 1 and in only 9 per cent of the cases in Group 2.

In the 50 cases in Group 3 (lymph nodes free and patient alive) factors were present in 61.5 per cent of the cases and absent in 38.5 per cent.

In the 51 cases in Group 4 (lymph nodes involved and patient dead) factors were absent in 61.3 per cent of the cases and present in 38.7 per cent, just reversing the figures of the previous group.

TABLE II — COMPARISON OF GROUPS 3 AND 4

	C l y m p h i n f i l t r a t i o n p r e s e n t	P a t i e n t l i v e	G r o u p 3 d e a d	P a t i e n t d e a d
Cellular differentiation present	84		51	
Cellular differentiation absent	6		49	
Fibrosis present	80		49	
Fibrosis absent	20		51	
Hyalinization present	46		17	
Hyalinization absent	54		83	
Lymphocytic infiltration present	36		36	
Lymphocytic infiltration absent	64		64	
All factors present	1		4	
All factors absent	6		24	
Total per cent of factors present	61.5		38.7	
Total per cent of factors absent	38.5		61.3	

CONCLUSIONS

1 The preponderance of evidence indicates that cellular differentiation fibro is hyalinization and lymphocytic infiltration are nature's defensive mechanism against carcinoma.

While the evidence doubt are not the only means of lesion they are probably the most important.

They play a definite and distinct part in retarding the growth of carcinoma in the breast.

4 They are not present in every case and vary considerably in degree and thus in effectiveness.

If following amputation in a case without involvement of lymph nodes all the lesionive factor are found present a good prognosis is justified if they are not present the prognosis is not so favorable.

6 If in a case with involvement of lymph nodes there are no factor present the prognosis is poor. If all the factor are present it is still not good but certainly better.

7 The results emphasize more than ever the necessity of early diagnosis and radical amputation for carcinoma of the breast.

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- 4 M C 33 35 W C Ca c ma of th b st T
So th S g & Cyn c A 9 6 7
- 5 Id m The h t f c ma f th b t
d t l l fi nc S Cyn & Ob t
- 6 Id m Cl al g ton ba d p n st dy of
p m ry d ry (ca m) and te t ry or
m t y (m) p thel l hyp rpl th
b t S r Cyn & Ob t 9 4 84 89
Id m F tr h h fl ce lo e ty in c c
A S k 9 l q 2
- 8 Id m Th l t f f b d hy l t on t
l sc ty c n J L b & Cl M d 9 2
- 9 Id m P 43 o f ct s n c r An Ch Med
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GALL-BLADDER DISEASE IN YOUNG SUBJECTS

By ALFRED H. IOTTLER, M.D., SPRINGFIELD, OHIO

THE incidence of gall bladder disease in adolescents and patients under middle age has always been considered as very rare by most medical writers. Moreover a perusal of standard works on pediatrics including the latest and best textbooks written in the most interesting and presumably the most instructive way would give one a wrong impression upon this subject and would rather suggest that they cannot be based upon actual experiences outside of that of the authors since they hardly mention anything in reference to gall bladder disease in children or at least imply that gall bladder disease is a matter of but slight importance in childhood and adolescence. The writer's personal experience and study of the literature has however led him to a quite different opinion and it is the purpose of this paper to show, with the help of collected data, that gall bladder infections occur most frequently in adults under middle age and that such diseases including the occurrence of biliary calculi may be met quite often in adolescents and young children.

The writer has within the past 3½ years personally observed 4 verified cases of gall bladder disease in patients not over the age of 15 years the histories of which are given at the end of this report. This fact was so unusual and so much at variance with the accepted ideas on the subject that the writer was led to investigate the literature of the age incidence of gall bladder disease with special reference to infants, children and young adults. This investigation appears clearly to establish the statement already made that gall bladder disease is much more prevalent in young subjects than has hitherto been commonly believed and furthermore that as regards the age incidence in diseases of the gall bladder and biliary passages a restatement of our more exact knowledge and a correction of the misstatements upon which our beliefs in the past were based would appear to be absolutely essential.

To prove my contention that gall bladder affections are found in patients under middle age of life more frequently than believed in the past I will quote as follows. In a series of 259 operations on the gall bladder it was found that in over 15 per cent of the cases the patient was under 30 years of age.

Mann and Wilson (77) in a study of 57 cases of chronic gall bladder disease in young adults operated on in the early stages of the infection found that more than 90 per cent were under 35 years of age.

Starr also states that in over 36 per cent of cases under observation there was a history of biliary attacks before the age of 25 years.

STATISTICAL DATA

A study of statistics of something like 25,000 cases of gall bladder disease collected from the reports of well known clinics and hospitals shows the average age of patients at time of operation to be for females 36 years and for males 39 years. Although the duration of symptoms varies greatly the study further shows that for females the symptoms last from the time of onset to the time of operation for an average of 6 years and for males 5 years.

The shortest and longest duration from the time of onset of symptoms to the time of operation were 3 hours and 39 years respectively. Of course many factors intervene in regard to the time when patients seek surgical relief from their suffering. But the figures would apparently prove that the age of incidence of gall bladder disease is on the average 30 years in the case of females and 34 years in the case of males. This is to say that judged from the statistics one must believe that gall bladder infections begin to give symptoms in the most active period of life and then place the average age incidence far below that generally accepted in the past.

With regard to the occurrence of gall bladder disease in very young subjects beginning with the case published by Gibson (58)

in 17 and including case reported up to the end of August 1917. I have been able to collect 6 cases in this period in children. The number would I am sure be greatly increased if all observed cases had been reported. The review shows that pathological condition of the gall bladder or ducts were observed in children under 15 years of age and were diagnosed by the symptom and verified either by operation or autopsy.

An outstanding feature in this review is that the colored race is far less frequently affected with gall bladder disease than the white race. Another matter regards the symptom that while in many cases the symptom in children were typical as in adult yet children are rather inclined to complain of abdominal pain when gall bladder disease is present because they are apt to direct most pain to the abdomen. Indeed in adult many symptom of cholelithiasis is which is directed usually to stomach and liver trouble biliousness indigestion dyspepsia etc. will be found in such a history and will often lead to the diagnosis of biliary calculi before marked symptom have presented themselves. Friedel (110) claims that cramp in the stomach are caused by gall tone in 94 out of 100 cases. When the so called cholelithic symptom are present there is little difficulty in making the diagnosis.

THE OCCURRENCE OF GALL STONES IN YOUNG SUBJECTS

It is still believed by many that gall stone practically never occur during the first decade of life and but rarely in the second. It is also believed that they are infrequently seen prior to the thirtieth year and that afterward they become progressively more common with advancing years.

In more than 3000 autopsies gall stone were found in 1 case in every 50 by Naunyn (10) in persons up to 60 years.

It is stated by Hekt and Die man (60) that biliary calculi are found in 5 per cent of all cadavers at autopsy after the sixteenth year. It has been stated however that gall stones in patients under 1 year of age are quite unusual. With this statement the writer is in accord.

Mathews (81) thought that at least one half of the patients upon whom he had been called upon to operate for gall stone were under 30 years of age.

It is quite impossible from the collected statistic to determine definitely at just what age biliary calculi are formed but review of the literature has shown that such calculi have been found at all ages from that of a 6 month fetus to a patient aged 86 years.

ETIOLOGICAL CONSIDERATIONS REGARDING GALL BLADDER DISEASE IN YOUNG SUBJECTS

Certain etiological considerations would appear to support the occurrence of gall bladder disease in young subjects.

In the past it was fairly accepted as a fact that typhoid fever was generally the preceding etiological factor in gall bladder disease but in recent years and at the present time it is accepted that other pathological condition such as influenza appendicitis scarlet fever diphtheria etc. in the order named can be preceding factor.

Medical literature shows a great decrease in the number of typhoid cases in the past few years and if this decrease continue typhoid will be practically eliminated.

The twenty fourth annual report of the U. S. Census Bureau shows a very great decrease in death from typhoid fever even in the face of an estimated population increase. But this report also shows a great increase in death from influenza and from this fact it is my belief that influenza is supplanting typhoid as the preceding etiological factor in gall bladder disease.

The infectious disease of children have however not received the attention they deserve as preceding factors in the evolution of gall bladder disease but I think that there can be but little doubt of the important role which the diseases play in infections of the gall bladder and biliary tract especially in the young.

Many conditions are a frequent concomitant if not an etiological factor and according to Jones and Joyce (65) in every case of pernicious anemia they have come in contact with in the past few years a chronic infection

of the gall bladder has been positively demonstrated. A small number of cases which resembled mild pernicious anemia possessed the same type of biliary infection and upon its removal the patients were restored to fairly normal health.

Digestive tract infections no matter how they originate must be considered the most probable origin of gall bladder infections in the very young but this precludes a stagnation of the gall bladder.

In cholecystitis stagnation of the bile in the gall bladder is the main predisposing cause of infection. Hence the stagnant gall bladder may almost assume the importance of a clinical entity.

The gall bladder should not be viewed as an actively functioning organ that rhythmically fills and empties itself under the stimulus of digestion. An enormous concentration of bile in the gall bladder takes place with the addition of a mucous element. As stated by Mann (76) the most recent investigations have proved that the gall bladder has at least one function viz. concentration of the bile and plays a role in the regulation of intra-biliary duct pressure. But the flow of bile originates in the liver and sweeps down through the ducts into the duodenum disregarding in the main part the gall bladder and variations in the bile flow and concentration occur in the liver in answer to the various degrees of food stimuli (7).

The gall bladder as an active organ does not seem to enter into the physiology of the bile excretion the outflow from the gall bladder appearing to be in the nature of an overflow incontinence.

Because of the small amount of smooth muscle in the wall of the gall bladder it is probably more correct to say the gall bladder evacuates rather than contracts.

Hydrops may be a condition affecting gall bladder stagnation. As pointed out by Kehr (66) hydrops may be transitory or permanent. Acute infections of the gall bladder and cystic duct of a mild character usually are accompanied by hydrops. With the subsidence of the inflammation the cystic duct recovers its function drainage of the gall bladder occurs and the hydrops disappears. Heister's valves

are swollen because of adema of the mucous membrane of the cystic duct and this may be the cause of the already described condition. It is stated that a constriction of the sphincter of Oddi may be the cause of the same condition. But the most important factor controlling the overflow of bile from the gall bladder and biliary passages is the motility and tonus of the duodenum as pointed out by Burget (1).

I wish to report the 4 following cases of interest coming under my personal observation in the past 3½ years.

CASE 1 September 24 1923. A well nourished boy aged 11 years had abdominal pain and vomiting for 5 days before examination. The only previous illness was measles at the age of 6 influenza at the age of 10. The patient had had dizzy spells and vomiting several times during the past year. His skin was slightly jaundiced. He was drowsy without opiate. The right side of the abdomen was rigid and tender with marked tenderness 1 inches to the right and upward from the umbilicus tenderness over McBurney's point distention and tympanic abdomen especially in the epigastric region very marked tenderness on palpation just below the twelfth rib in the midaxillary line on the right side. The temperature was 102.4 degrees F pulse rate 106 respiration 44. The blood count showed leucocytes 23,400 polymorphonuclears 94 per cent. Urinalysis was practically negative. A provisional diagnosis of acute appendicitis and acute cholecystitis was made. A laparotomy was performed that same night and showed a moderately inflamed elongated high placed appendix kninked and adherent at its mid portion and its distal end adherent in the region of the common duct. The latter was inflamed and thickened. Exploration of the gall bladder revealed a greatly enlarged oedematous organ (hydrops) under great pressure. The wall was of a grayish color. It contained 178 cubic centimeters of mucus which was bile streaked at the end of aspiration. The gall bladder was opened and explored no tones were found. With some difficulty water was forced through the ducts the gall bladder was scrubbed out with gauze and a rubber tube drain inserted. Pathological findings indicated that the condition was a subacute appendicitis. Culture of bile gave no growth. The patient had an uneventful recovery after appendectomy and cholecystostomy.

Postoperative notes. The discharge of mucus through the drainage tube stopped on the sixth day after operation then bile escaped from that time on. The jaundice cleared up in 9 days after operation. The temperature was not normal until 10 days after operation. On March 17 1927 3½ years after the operation was performed the patient was in excellent health.

CASE 2 A poorly developed boy aged 6 years presented a picture of severe illness. He had had but one previous illness of any consequence viz. catarrh of the bowels at the age of 4 years and after which he had not enjoyed the best of health. His complaint dated from a few days after Christmas. He had attacks of colic like pains in the abdomen on every other occasion he had diarrhoea, fever, anorexia, furred tongue, foul breath and light yellow color of skin (not jaundiced). Examination January 8, 1924 showed the face flushed, the skin light yellow, the color of the chest negative, the abdomen greatly distended with some rigidity of the right rectus. He was very sensitive to pressure over McBurney's point and the epigastric region. There was seen no tenderness of the gall bladder region. The temperature was 103 degrees F. Pulse 100. Respiratory rate 30. Blood count showed 11,000 leukocytes, 13,000 polymorphonuclear, 78 per cent. Urinalysis was negative. A diagnosis of acute suppurative appendicitis was made.

At operation a right rectus incision was made over the appendix and was found rather high. The peritoneal cavity contained a serous exudate. The appendix was rather high placed and the omentum completely surrounded it but not firmly attached to it. The division was released and delivered out of the abdomen and removed. The appendix showed acute inflammation. As we were not satisfied that this would cause all the symptoms the incision was lengthened and exploration of the gall bladder revealed a moderately distended organ. It could not be emptied and under gentle pressure exploration revealed a small conical shaped mass in the neck of the gall bladder but it did not have the consistency of a stone. A pipette failed to withdraw the content through needle but when the gall bladder was incised black tarry like bile was poured out. The bile was thick and contained sand without difficulty the conical shaped mass was removed from the neck of the gall bladder. It had the consistency of wet sand. A drainage tube was inserted in the gall bladder and another was inserted in the right kidney region. The patient's condition was slightly stormy compared to Cases 1 and 3 although he made a complete recovery. A diagnosis of cholelithiasis, cholecystitis and acute suppurative appendicitis was made. Cholecystectomy and appendectomy were performed.

The pathological findings showed an acute suppurative appendicitis. The bile gave a culture of mixed infection.

On January 19, 1927 the patient was a robust healthy individual enjoying good health.

CASE 3 A well developed but obese girl aged 15 years had had the usual case of childhood anhidrosis and influenza in 1913. She had not had fever or respiratory distress. On February 19, 1924 the patient gave a history of typical gall bladder colic. In July 1923 she began having what was diagnosed as indigestion. The attacks were sud-

den in onset and accompanied by vomiting and pain in the epigastrium radiating to the back via the ribs and right shoulder. There was no history of jaundice of the skin until the present time although the sclerae were occasionally icteroid in color. There was soreness on deep palpation in the gall bladder region but there was no rigidity and there were no palpable masses. She gave birth to a child on November 2, 1923 and since then had had attacks of pain every week in the gall bladder region but with no definite relation to meals and no vomiting or constipation. Occasionally light pasty stools were passed. The last attack occurred a week before admission and required an opiate. Her temperature was 97.8 degrees F. Pulse was 62. Respiration 14. Blood pressure was 110-65. Blood count was leukocytes 9,000, red blood cells 3,150,000, haemoglobin 70 per cent. The patient nursed her baby up to the time of her entrance to the hospital. Urinalysis on February 5, 1924 showed a specific gravity of 1.04, a trace of sugar, negative for albumin, acetone negative, bile negative. On February 9 the specific gravity was 1.032 and there was 0.5 per cent of sugar. A preoperative diagnosis of cholelithiasis, chronic cholecystitis and cholelithiasis was made.

On February 10 an operation with a high rectus incision was performed. Adhesions of the gall bladder to the intestines and peritoneum were released. The gall bladder was normal in size, bile was aspirated and was of normal consistency. The organ was opened and explored. Thirteen faceted stones were removed. One stone in the cystic duct was milked back into the gall bladder and removed. A second stone in the cystic duct near the ampullar end was crushed and removed. The other ducts were clear. A total of 15 stones was removed. The largest stone was the size of the end of the little finger. A rubber tube drain was inserted in the gall bladder. Exploration of the appendix showed it to be retrocaecally located, adherent and in a state of subacute inflammation. It was removed. Pathological findings indicated a subacute appendicitis. Culture of the bile was negative. The patient had an uneventful convalescence and was discharged on February 24. Cholecystostomy and appendectomy were performed. On March 1, 1927 the patient reported that she had been in good health since the operation.

CASE 4 A fairly well developed girl 15 years of age, 4 years and under weight as admitted September 10, 1926. She had pain in the right side, lower and upper quadrants and rigidity of the right rectus. She complained that vomiting and flatulence had been present for the past days. She had had stomach trouble for years, flowing influenza and had had three previous attacks with symptoms similar to those of the present illness. Examination revealed an abdomen greatly distended, rigidity of right rectus tenderness over the umbilicus marked at a point 2 inches to the right and up a few inches from umbilicus, slight tenderness over McBurney's point.

CAL-BLADDER DISTASI IN YOUNG SUBJECTS

N	th	S	Ag	Ch	Ch	Ch	P th l py	Sympt	How D g o d Al Tyj f
7	C b	M l	Y	Y	Y	Y	Ac t t M l l l d d mm led	P t m t g l f	At ty
75	Coe	L k	L l	Y	Y	Y			At ty
3	75	L t l	M l	d	5	Yes	E l g l l d l l l	C l l t j f	At py
4	83	I t l	L k	I f t	Y	Y	L n l l d h b l o l		At py
5	83	I t l	U k w	I f t	Y	Y	I h l l d h l l o l		At py
6	83	I t l	I m l	5	Yes	Y	B l l l l l d t h b l a y l l	D p e s m f m l t d l g e d	At py
7	8	B h y t	M l	Y	Y	Y			At py
8	8	B h y t	L k	t	Y	Y			At py
9	8	C l h	L k	m	Y	Y		I t l o s	At py
8	9	C l h	U k	I f t	Y	Y			A t o p y
81	O f l	M l	Y	Y	Y	Y	D k e l l h t g m		At py
834	Lol t t	M l	5	Yes	Y	Y		Abd m l t t d d t t t h l t y t p t	Sympt m (t t d fac)
3	835	H so	U k	8	N	Yes	P l t t t t t l l l l	Typh d f	At py
4	835	V ll	U k	I f t	Y	Y			A p y
5	835	V ll	U k w	N b	Y	Y			At py
6	835	V ll	U k	N b	Y	Y			At py
7	843	B so	U k	N l	Y	Y	C m d t t l l k l l k l l m	Abd m l p l t e	At py
8	85	A h m b l t	U k w	I f t	Y	Y	U t t h l y I f t f k l l l d d	Typh d P t t	At py
9	853	B th d	U k w	Y	Y	Y	R p d g l l b l d j t t l g	Typ l	At py
86	T	F m l	o	Y	Yes	Y		Typ l g l l t l	S p m
86	W l l	M l	Y	Y	Y	Y			Sy pt m (t t f l fac)
86	F h	I m l	7	Y	Y	Y	L d d d f l		At py
3	864	R y	U k	5	N	N	C m m p p d l t d l t P f t d A l y f l l	I t t	At py
4	864	Ch d g	U k	5	N	Y	U t h l c y t	Typh d	At py
5	869	M r	F m l	Y	Y	Y		I t m t t f t k f l with t	At py
6	87		U k	5 t	Y	Y			Sympt m
7	87	S	U k	5 t	Y	Y		Typ l g l l b l d d l	ympt m
8	87	S	U k w	5 t	Y	Y		Typ cal g l l b l d j l	Sympt m
9	877	C f f	M l	d	Y	Y	G l l b l a d d d d t m l l d t C y t d b y l l	Hem ph	At py
3	879	A d d	U k w	U l	Y	Y		C l	Sympt m (t t l fac)
3	88	m	I m l	5	N	Y		C l	At py (t fac)
3	88	M	I m l	4	Yes	Y		G l l l d d ympt m d l t	Sympt m (t t l fac)
31	88	M	M l	8	N	Y	Y	Ch t t t hep t l	Sympt m
34	88	B l	U k w m	8	Y	N	Y	Imp t l t mm l t	At py
35	88	W l k	M l	3 mos	Y	Y	Y	C l	Sympt m (t fac)
36	8	St d m	F m l	3	N	Yes	Y	U l t h l e c t t l f f Typh d t t Typ l	At py

GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Contd.

N		A h		Ag	U h	Ch l		P h l g y		ympt m	If w Dag used. Also Type f Ope
7	88	S dm	I m l	6		Y		pe f f d f g l l b l d d		Typ h d P t	A t p y
8	88	f	I l		N	Yes	N			At ks f m ep d d esa	ymp m
9		M	M l		N		Y	H pe b l		B l ry t t	m m
10		M	F m l		N	Yes		Hyp b l		Abd m al p	ymp m
11		M	M l		N		N	A f d i lcul h ppe dux		P	A psy
12		R d	t k	U d	Yes		N			Abd m l l	S mp m t
13		B l	M l		Y	Y	N	F t l m pe f f l l b l d d Empty m t g l l		Of ph d d m	A p y
14			t k	L l S	Y		N	V r v l			

GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N		A th	Ag	Ch l	Ch l	I	P th l gy	Sympt m	H w D gnosed Also Type f Ope t
67	800	St II	F m l 8 m	Y		N	T be cul m g tus M l y t b l	C b l sympt m	A t p y
68	800	t II	M l 5 mos	Y		N	B h p m C leul g ll bl dd	S bd m l p m t g p l tool p lp bl	A t psy
69	800	St II	M l	N	Y	Yes	V sc ty f bl	V m t g, bdom, l p l geel d p lp bl g ll bl dd	Sympt ma
7	99	St II	L k I f t	Y	N	Yes			A t psy
7	800	St II	L k I f t	Yes		Yes			A t psy
7	800	St II	L k I f t	Y					A t p y
73	800	St II	U k w I f t	Y		Y			A t psy
74	800	t II	L k I f t	Yes		Yes			A t psy
75	800	St II	L k I f t	Y		Yes			A t p y
76	800	Still	U k I f t	Y		Yes			A t p y
77	800	St II	U k I f t	Y					A t psy
78	800	Still	L k I f t	Y					A t p y
79	800	St II	L k I f t	Y					A t p y
8	9	O l	F m l 5	Yes	Y		D g f t k f t t k f typh d d w m p ed fac ta ed w th bl	Abd ma l l l yph d f	A t p y
8	9	R llet	M l 6 m	Y	Y		E h g d l d pl B h p m G ll bl d l m ll cy t d t t phed comm d t d luk U h bl t ed	A x m t m f l ght l y l ed tool	A t p y
8	9	M b ll	M l	N	Yes		D t ded g ll bl d l W B C ooo C l t f m g ll bl dd h d b ll typh	S bd m l p Ab d m l t d es R g d ty f m les bl b d m l t m	Ch l y t t my
83	95	R d l	M l 9	N	Y	Yes	B ll l		Ch l cy t t my
84	9	C	I m l	Y	Yes		G ll bladd ta ed p b t b l	Typ l f cut feet f g ll bl d l T mp l W B C 33 ooo	Ch l cy t t my
85	96	D H C	M l 3	N	N	N	R pt f g ll bl dd	F m t g m t gee h p d p l b d m d t d ded I m ght hypoch d m	Ch l cy t t my P l dr in g
86	908	hl g	L k w 4 m	Y		Y		Abd m l p	A t p y
87	93	F edj g	U k 4 m	Y					A t psy
88	98	A hh t	M l	Yes			I f t f g ll bl dd I t d (us assoc t d th bl t ed	lyph d f bd m lp pe t ts	A t p y
89	98	Still	F m l 3	N	Y		C l t f p f m g ll bladd h w d b ll typh	Sh p bd m l p un t d es g ll bl dd g l ty f ght t m f T mp F	Ch l cy test my
9	908	F d l d	M l 5	Y	N			C l f d t d ded g ll bl dd p lp bl	Ch l cy t t my
9	909	M y Cl	F m l 5	Y	Y		St oed m y t d t G ll bl dd Hyd p	P n d ght co t l m g f s y T d ss ght h p h dr m	Ch l cy t t my
9	909	R d l	I m l 3	N	Y	N	G l d l lling f hep tod d l lag m t	C l	Ch l y t t my
93	909	M t b k	M l 5	N	Y	N	A t hydr p s p t d G lly d t m d g ll bl dd	P t d es p lp bl	Ch l y t t my
94	909	C h y	F m l 1	Y	Yes		Sm ll g ll bl dd h w f b		Ch l cy t t my
95	99	W t	M l 3	N	Y	N	Empy m f g ll bl d l A t ppe d t	I t d hypoch dr m P lp bl g ll bl dd	Ch l cy t t my Appe d t my

GALL BLADDER DYSPLASIA IN YOUNG SUBJECTS—C 1 d

N		A h	A	U	U		P h l y	mp m	H D os d Al Typ f
pc	W	F m l	N	Yes			Emt s m f l l bl d f ppe k	Tyr l	Ch l y y
o	C l W h	F m l	s	Y	Y	N	C l l f b l f m l l bl d	E p bl d d l T m l l f b e E m p p l f	Ch l y m
s	l	M l		Y					O t A f ?
	Ch h	T l	N	Y			A bl d l h d l h l G l l m l B C o o o d h k l l	S h y p o c h d l f f m l R h d d l f f m l p l	Ch l y my
oo	l	U k	T l d	Yes	Y		b l y l l f i x l	B l r y C l C h l	y m p m
	P	F m l	N	Yes			Th k o o o l l d g l l bl d W B C	P l d d b l m d l l d m d h m k l	Ch l my
	Ch l l	F m l	N	Yes	N			C l	O p e A ?
	m	F m l	N	Yes				A b d m l	Ch l os my
	l k	M l	8	N	Y	Y	E o o h y l r p f l l bl d l l l m d d a s e d A	l h d l a g p l b l M l d p f f p d l y f h h	Ch l y A p p e d m
s	Och	F m l	N	Y			A h l	P d b d m p p h	Ch l y os y
	R	M l	N	Y			P l l l A p p e d m l l y l p f m l l l l l h d b l l d l C l h	P	Ch l os my A p p e d m
	l	U k	N	Y	N		l l l l y d d d g l l b l d l G l y d	A b d m l f d d	h l y my
o	kh	U k	N b	Y	N	Yes		C l l b o	m p m A l ?
	kh	T l		Yes				A l m l	A p
	kh	M l		Y					A
	kh	T l		Y	Y				A
	kh	T l		Y					A
	kh	T l		Y					O
	kh	T l		Y					
	kh	F l		Y					
	kh	F l		Y	Y				
	kh	F m l	s	Y	Y			A l m l	C
	kh	M l	U d	Yes	Yes				O t
	kh	T l	U d	Yes	Y				O p e r
	kh	F m l	U d	Yes					O t
	kh	T l		Yes	Yes				O t
	kh	M l	U d	Yes					O t
	l b	M l	N	Y	Yes		F r e d o s b h p p e l h b o c e s	F t l s o c h e d h m l l	Ch l y
	l l		N b o		Yes		f l l l a d l		A p o
	l l		N b o		Y		f l l l a d l		A o r y
	l l		N b o		Yes		f l l l d l		A p
	l b e		N		Yes		f l l l d l		A p o
s	l o e		N l		Yes		f g l l b l a d d		A
	l b e		N b o				f a l l b l d l		A y

GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N	Age	Sex	Age	Chl	Chl	Id	Pathology	Symptom	H. D. g. used Al. Typ. Op. t.
3	9.4	El	W	bo			St t f g ll bl dd		A t psy
3	9.4	E h	U k w				At t psy-L m l d t ept y t m l g ll bl l b t l f f g ll bl ad t g	I t t gh pl tool	A t py
3	9.4	Aym Om		I f t	Yes				A t py
33	9.4	Cl k	M l	4 m			C g t l d l f t f t t f m l Hydr p f g ll	A t t l t	A t py
34	9.4	D	I m l	3	Yes to m		I p t d g os t pl	Of t ppe d t	Ch l y t t my App d t my
35	9.4	P l		6 m					A t psy
36	9.5	B bcock		4			Ch l y am		Ch lecy t t my
37	9.5	B bcock			Yes		Ch l y t t am		Ch lecy t t my
38	9.5	B h		5					Ch lecy tost my
139	9.7	E d th	F m l	5	Yes to	N	(ll bl) dd d t f d f l l d th p rul fl l y d t g tly d t led w th 4 t es	P d t ght hypoch d m d t l t ht h ld Abd m g l t d ht ppe q l t F v m t g	Ch l y t t my
4	9.7	E fr th	I m l	5	Yes to		A t pp d A t hyd p	v t p ght pp q d t v m t g M k d bd m l d R b d ty ght l g	Ch l y t t my App d t my
4	9.8	Sm th	F m l	1	Yes				Ch lecy tost my
4	9.8	Sm th	M l		Yes				Ch lecy t t my
4	9.8	Alb					Ch l g	V t—Alb d be l g mb f wh h h d g t d t h l cy t t d h t g t W l d W h b l d ang	Symptom
44	9.8	K l	F m l	8	N		G ll bl dd d t d l w th 700 m f b C h h ed p t f b ll typh Ch l y t t th d haem	F d l m h d h d rhar m t f b d m W B C d 400	Ch l cy t t my
45	9.9	Ch mb	F m l	5	N		P-op t d g h l l th	Ch lly t f d m l p g cot b t t k f sym p m	Ch l y t t my
46	9.9	L d	I m l	8	Yes to		G ll bl dd d t d d W B C 6	Abd m l mp t d v m t g ght hypoch d m	Ch lecy test my App d t my
47	9.9	D H C	F m l	5	N	Yes to	Typh d g t d g l l l dd w th ec t f d P l t fl d f m h h h y b ll g w	A t bd m l p p t l r t t	Ch l y t t my
48	9.9	C ll w y	M l	4	Yes		Typh d	6 t t k f f b l y l y	ymptom
49	9	J bso	F m l	4	Yes to		Old p h l y t dh d h k g ll bl dd	Abd m l t d p pp ght bd m d t g t b k d ght h l l N m t	Chol y test my App d t my
5	9	J bso	M l	3	N	Yes	b t h l y t t N t	I d t d t mp oo 6° F W B C 8000	Ch lecy t t my
5	9	K dy	F m l	3	Yes to		App l t d t t l m	Abd m l p ght hypo- h d m g d m t g y t t	Ch lecy tost my App d t my
5	9	Ed t	F m l	5	Yes to		P-ope t d g App d t W ll f g ll bl d l y t k	P g d y pp ght m t g t d M B y	Ch l cy tost my App d t my
53	9	B ll	F m l	4	Yes		P d t d h l y t t A t ppe ooo C ll bl d l t t d 32 f p l t p	F p g l m l bd m t d es m f bd m t d pp ht a d t	Ch lecy tost my App d t my
54	9	F dl h	U k w	I f t			St m l mm d t G ll bl dd		A t py

CALL BLADDER DISEASE IN YOUNG SUBJECTS—C i d

N	A h	S	A	U	U	U	P h l g y	S r p m	H D os d Also Ty ne
00	W	F m l		N	Yes		Em y m f fl bl fl f pe k	Typ f	Ch l y oet my
000	C l f W h	F m l	S	Y	Y		f l f b l f m fl bl d l	E bl dd pa y l fl f f E m p l fl bl fl	Ch l ec y os y
8	l	M l		Y					Ch l y ?
00	Ch hin	M l		N	Y	Yes	Ac f l fl h f l h l y k l l G l l m l W B C ooo	bd m l pa R h h d d m fl fl f p l d bl	Ch l c y
00	C l so	L k	Ch l l	Y	Y		S b l r y l l f f	B l y C l C h l	y f m
	l	f m l		N	Y		Th k w l l d fl bl fl W B C ooo	P bl dd f l m f g l l b d m t m k l p m p h	Ch l y my
	Ch l l	f m l		N	Y	N		C l	Ch l y ?
	N m B k	F m l M l		N	Y	Yes	E m h d p f l fl bl dd f d m fl f ed A	Abd m l p l h j f l f l p b l m m B p f l po es f f d f h q e e f	Ch l ec Ch l f d m y
	Okh	F m l		N	Y	N	A h l	P d b l m p h	Ch l y my
00	R m	M l	S	N	Yes		P l d os es l p e f fl med G l l bl dd m l l y d f h C l h ed b fl	F	h l os m y A p l y
	M	L k		N	Y	N	F l d l f d ed l b l l	Abd m l d d	Ch l y y
00	Kh	L k		Y	N	Yes	fl fl	C l l b	A m m A p ?
00	Kh	M l		Y				Abd m l pa	A
	Kh	f l		Yes					A f
	Kh			Y					A f
	Kh	M l		Yes	Yes				A f
	Kh	M l		Y					A
	Kh	f m l		Yes					Ope
	Kh	f m l		Y					Or
	Kh	f m l		Y	Y			Abd m l	O
8	Kh	f l	L l	Y	Y	Yes			Or
	Kh	f l	L l	Y	Y				O
	Kh	M l	L d	Y	Y				C
	Kh	f m l	L l	Yes					O
	Kh	f l		Yes	Yes				Or
	Kh	f l	L l	Yes					Or
	Pyb	f l		N	Yes	as	Pr ope d g as b h pa p p e d h b es	P h p p e h m f l ll ueh h pa	Ch l c y y
	fl			Yes			S f fl bl d l		A p e
	fl			Y			f fl bla f l		A op y
	fl			Yes			f fl bl dd		A f
	fl			Y			f g fl bla d l		
8	l			Yes			f fl bl d l		or y
	fl						f fl bla d l		A y

no	A th	s	Ag	Ch l lth	Ch l y t	J d	P th l y	Sympt m	If w D e oed Al-o Type f Ope t
3 19 4	Fl		N w bo				St t f g ll bl ll		A t p y
3 9 4	E h	U k		N	Y		At p y-L m l d t pt y t m l g ll bl dd l t g f g ll bl l	I st t gh p le tool	A t psy
3 9 4	Aym Om		I f t	Y					A t p y
33 19 4	Cl k	M l	amos	Y	Y		C g t l d d f t P t t f l id Hydr p f g ll	A t t l t	A t p y
34 9 4	D es	F m l	3	Y to es	Y cute		I op d t t pt	O t t ppe d t	Ch lecy tost my App d t my
35 9 4	I l		6 m	Y					A t psy
36 9 5	B beock		4	Y			(h l y t x m		Ch lecy t t my
37 9 5	li bc k			Y			(h l y t t x m		Ch l cy teet my
3 9 5	li h		5	Y					Ch lecy tost my
39 9 7	E d th	F m l	5	Yes to es	Y	N	C ll bl ll d t d d d d d th l l t d d d t d t g ly	P d t t t ght hypoch d m Abd m g d t d ht ppe q d t F m t g	Ch lecy teet my
4 9 7	L J th	I m l	5	Y to es	Y ac lo		A t ppe d t A t hyd p	N p t ght pp q d t m t g M k d bd m l t l R g d t y kht l eg	Ch lecy t t my App d t my
4 9 8	Sm th	F m l	5	Y	Y				Ch l cy t t my
4 9 8	Sm thes	M l	5	Y	Y				Ch lecy t t my
43 9 8	Alb			Y			Ch l g	V t - Alb t b a l g mb f d t h h d g t d t k h l t t d h l g t curr g hldr d g W l l w	Sympt m
44 9	R d	F m l	8	N	Yes		G ll bl dd t t d d th 700 m f p Cl t h ed p t t t f b ll typhos Ch l h t th t haem	F d d m h d h d h e h m t ght d f bd m W B C 400	Ch l y t t my
45 9 9	Ch mb s	F m l	5	Y	N		P -or t d g h l l th	Ch lly t t f t b d m l p m t g f q t t k f y m t m	Ch l y t t my
46 9 9	L d	F m l	8	Yes	Yes cute		G ll bl dd d t ded W B C o oo	Abd m ght hyp h d m A m t g	Ch l y t t my Appe l t my
47 9 9	D H C	I m l	5	N	Yes t		Typh d g t d g ll l d t th f d f P l t f l f m w h h y b ll g w	A t t b l m l p p l l t t	Ch l y t t my
48 9 9	C ll w y	M l	4	Y	Y		Typh l	4 6 t t k f b l y l Y	Sympt m
49 9	J b	F m l	4	Y ma y	Y		Oil p h l y t dh h k g ll bl d t	Ab l m l t d p d t p r ght b l m h l t g t b k l ght m t g N	Ch lecy t t my Appe d t my
5 9	J b	M l	3	N	Y	Y	S b t h lecy t t N t es	P d d t d ppe bd m T mp oo 6 F W B C 800	Ch l y t t my
5 9	K dy	F m l	3	Y to es			Appe l t d t t l m	Abd m l p ght hyp h l m g d m t g t t	Ch l cy t t my Appe d t my
5 9	Ed gt	F m l	5	Y to es	Yes		P -ope t d g ll bl dd App d ly t W l l f g ll bl dd th k	l y t y pp m t g t d M B	Ch l cy t t my App dect my
53 9	L ll	F m l	4	Y	Yes		I d t d g l g A t ppe ooo C ll bl d t W B C f p l t p ed 35	F p f m b l bd m t d p m d bd m t d pp ht q adr t	Ch lecy tost my Appe dect my
54 9	I dl h	U k	I f t	Y	?		St m l mm d t G ll bl dd		A t p y

GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N	Age	Sex	Mar	Op	Pathology	Symptoms	History of Gall-bladder Disease
55	11	U	N	Yes	A	h l y s	Ch l y m
	11	F m l	Yes		G l l b l d d f l l f p d	Abd m l p	Ch l c y o s m
57	11	F m l	9	N	Y	P -ope d g l App d l b ess Imm t d led g l l b l d d g	Ch l y y Appe d my
58	11	M l	N	Yes	Y	F -ope dia os App d	Ope
5	11	M l	N	Y	N	App l sc l f	Ope
60	11	M l	8	N	Y	Ab f l	Up
	11	M l	Yes	Y	As	F h l l d m	Ch
	11	l l	Y	Yes	N	A ppe du	Ope
	11	F mal	Y	Y	N	Ch oed m d l	Ch l y my Appe dec my
	11	M l	N	Y	Yes	A ppe du G l l b l l l f m C l	Ch l e y my Appe dec m
	11	l l	Y	Yes	Y	A l l m b l y E	Ch l y my Ch ledoch y
61	11	F m l	Y	Yes	Y	T l h hypo h l m	Ch l y my
67	11	F m l	Y	Yes	N	F l p l g l l l	Ch l y y
	11	F m l	Yes	Yes	N	l l b l d d m l l h k l l d d p e l d es m l A f h k l l d	Ch l y ec my App l my
6	Lo	Le g	Ch l l	Y	N	A f l d b l y b	Op
	l l			Y		A p e f d p e b l c v w h	Ope
	l l	tn		Yes		A p f h C l l f f m l l b l l l h d b l l y p h	Ope
7	l		Yes			Acu p a d h l e y C l b p f l l b l d d p h l b l l bos	Ope
7	l	M l	Y	Y		F -op du A p f p b l l m ed f C l	Ch l c y my Appe d y
7	l	F m l	Y	Yes	Yes	F -ope d d b l e c s b h l l h as l b l f b l	Ch l c y y A p e d y
73	Fasc	F m l	N	Yes		Oed m p e s f m m d f m l l n l a g e d l m p h	Ch l e y my
7	Fisch	F mal	N	Yes		ph lococcus infec f g l l b l d l	Ch l e y my
	Fisch	F m l	9	Yes			Ope

GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N	Sex	Age	Chl	Chl	Chl	Pathology	Symptoms	Histology
78	0.4	F h	F m l	9	Yes	Empty m f g ll bl dd	Typh l f	At p y?
79	0.5	Z l g	F m l (l d)		Yes acute	B l i t h g h d t t l l g r i t cult f b l l l ty j h r t W l l	Typh d f p m f ppe b l m p m f b d m l m les g d ty t d p lly b l l b d d m	Symptoms
8	0.5	M	M l		Yes	C m f g h l l l l		At p y
8	0.5	E d m	M l	5	Yes	C m f g h l l l l		Op t
8	0.5	M y Chn	F m l	3	Yes			Chl y t t my
83	0.5	M Cl	F m l	3	Yes			Chl y t t my
184	0.5	B k	F m l	3	Yes	E m h l p f g h l l l l d t g l l l l l l l l m t h t l l l l l l l m	A d d h e m t g b d m d t d d f d d p o t k d t d p l s t m p f h d t p l y 7 W B C 7 500	Chl y t t my P t t l d y A t p y
85	0.5	M l h	F m l	5	Yes	l o p t t g l l l l	l d f m s m m t g b c m b l	Chl y t t my App d t my
86	0.5	G h l f	F m l	8	Yes	A t t f l l l l l l l l p e f l l l l l l l l	W k l h j d f m t b d m d t d l f m t g d h o r t f l M B s f	Chl y t t my A l l d t my
87	0.5	R b e t s	F m l	3	Yes taphyloco	H y f m l l l l l l l l l l m l l l l l l m t	Abd m l p g l p t f m t f g l t y f	Chl y t t my
88	0.5	l t t W y l l	F m l	9	Yes m i n t d t	C h l l l l l l l k l	l b d m l p g h t m t b d n g l t y	Chl y t t my App d t my
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GALL-BLADDER DISEASE IN YOUNG SUBJECTS—C i d

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bladder were thickened and very dark in color. On account of the child's condition the gall bladder was not drained, no stones could be palpated. Convalescence was retarded and complicated with acetoneuria. Postoperative diagnosis is acute gangrenous appendicitis, acute cholecystitis. Pathological examination revealed a gangrenous appendix. Postoperative notes September 11, 1906. Urinalysis revealed acetone and diacetic acid three plus. This condition persisted until September 2. Temperature 103 to 104 degrees F, pulse from 120 to 140, respiration 44 to 48 up to September 1. Temperature receded from 101 degrees (September 2) to 99 degrees F (September 4) when it became normal. Patient was discharged on the twentieth day. March 10, 1907 patient was enjoying good health.

STATISTICAL SUMMARY

Sex	
Males	6
Females	4
Not stated	90
Total	6
Ages	
Fetus (6th and 8th month Cases 21 and 34)	2
New born	1
Very young (age in days)	9
Infant	9
Child	4
Less than 1 year (1 month to 1 year)	14
Between 1 and 5 years	6
Between 5 and 10 years	5
Between 10 and 15 years	8
Total	6
Calculi	
Present	140
Absent	48
Not stated	38
Total	6
Jaundice	
Present	64
Absent	34
Not stated	128
Total	26
Cholecystitis	
With calculi	44
Without calculi	59
With jaundice	30
Not stated	93
Total	6
Calculi in ducts	
Cystic	14
Common	13
Hepatic	0
Not stated	109
Total	26
Hydrop of gall bladder	8
Infection of gall bladder	43
Malignancy of gall bladder (Cases 180 and 81)	2
Largest number of calculi found (Case 199)	1
Diagnosis	
By symptoms	1
Operations	16
Autopsy	9
Total	26

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BRAIN-FLAP—AN INFREQUENT OCCURRENCE IN CLINICAL SURGERY

ITS EXPERIMENTAL PRODUCTION

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IN 193 Sir William Wheeler (12) described a remarkable condition which he had observed during the course of an intracranial operation.

The patient had been admitted to hospital with his forehead bruised and cerebrospinal fluid trickling from his nose. He was breathing heavily and when his skull was opened a marked rise and fall of the frontal lobe occurred with respiration. Another feature of the case was the presence of air beneath the dura a condition which has been termed pneumocephalus or intracranial empyema.

With the exception of Wheeler's observation we have found no reference to any mention of a marked respiratory excursion of the brain in the course of an operation but it has since been the fortune of one of us (A.K.H.) to observe this condition on four occasions.

In the first case the condition appeared toward the end of an operation for hydrocephalus in a child performed by a former colleague Mr A. A. McConnell at the Richmond Hospital Dublin.

In the second there was a leak of cerebrospinal fluid from a dilated cerebral ventricle which had been opened during an exploration for abscess of the temporal lobe.

In this case the expiratory excursion of the brain was first seen at the trephine opening on the tenth day after the operation while the case was being dressed and it was then demonstrated to our colleagues Prof Biggam and Dr Barrada.

In the third patient who had lost much blood and was breathing heavily very large cerebral movements were observed after the removal of an extensive depressed fragment of the frontal bone just in front of the vertex which had deeply indented the dura without actually piercing it. These large movements

were observed for a period of 5 minutes during the closure of the wound.

The fourth patient had suffered an injury so similar to that in the third case that even before the skull was opened we ventured to predict a respiratory movement of the brain. This occurred at once on the raising of the depressed fragment of the bone and synchronized exactly with a deep inspiratory gasp but after 3 or 4 diminishing excursions the brain ceased to move. In this case the bone fragment had penetrated into the (superior) sagittal sinus.

Dr Ahmed Handoussi, surgical registrar to Kasr el Ain Hospital who operated on the fourth case has since observed an exactly similar condition in a fifth case the occurrence of the movement which was large at first which synchronized with respiration and which proved to be only transient.

In every one of our clinical cases it was clearly seen—in the first, repeatedly—that with expiration the brain bulged outward toward the opening in the skull and that it receded inward from the opening with inspiration.

These unusual movements of the brain are so large that from analogy with the flapping of the mediastinum which occurs with respiration in open pneumothorax we have ventured to coin the name brain flap.

In the first instance we were led to investigate this phenomenon by experiment because we believed that the occasional presence of air within the cranial cavity after fracture of the skull might be found to be in some way connected with it.

It was soon found however that while the apparent explanation of brain flap in terms of venous aspiration during the inspiratory suck of the thorax might at first sight

seem obvious and complete the condition in fact afforded a problem of some complexity. For this reason we have at present confined our experiments to its elucidation leaving the original question of intracranial aërocele for further study.

LITERATURE

With the exception of the paper by Wheeler already referred to we have been unable to find any reference to the phenomenon of brain flap in any surgical publication. It would seem that Wheeler himself was also unaware of the existence of any such publication.

The textbook both of surgery and physiology available at the time were also silent on the point. Again such journals as were accessible gave no hints as to whether any work had been done on this subject or not. In consequence we decided to perform the experimental work and hoped that during the summer vacation one of us would be able on his return to England to make a further search into the literature. This was fortunately the case and through the kindness of Sir Charles Sherrington we are able to cite some earlier work of which previously we had been in ignorance.

Moss (*1*) was able to examine the movements of the brain in 3 cases in man in which through injury or disease the coverings of the brain had been destroyed. He observed pulsation due to both the circulation and the respiration. To us it is somewhat surprising that his recorded change in volume due to respiration are so small in comparison with those due to the circulation. In our work as will appear later the latter were only occasionally observed while the former might be and often were very extensive. Moss attributed the change in volume to variations in the blood content of the skull following on the respiratory movement. Naturally he was unable to determine the effects produced by such procedures a section of the vagi.

A paper by Kov and Sherrington deals with a variation in cerebral volume (*8*). The work there described was undertaken with the desire to determine the presence or absence of a variation apply to the cerebral vessel. There were certain differences in technique between their experiment and our and if

we remember the differences between their objects and ours it is not surprising that they only incidentally mention the effects of respiration on the cerebral volume. As far as the procedure in the two sets of experiments is similar the results show a close resemblance a fact which gives us the greater satisfaction in that our work was done in complete ignorance of the earlier publication.

These two publications are the only papers in which we have been able to find accounts of work done under conditions similar to our own in that the cranium has been opened and its contents exposed to atmospheric pressure during the whole of the experiment. Hill (*3*) has published the results of experiments on the actual cerebral volume but with the trephine opening blocked. All other work such as that of Knoll (*4*) Becht (*1*) Weed (*10*) and very many others deals solely with intracranial pressure and almost always under the conditions of a closed cranium.

EXPERIMENTAL METHODS

For the purpose of this research dog of from 4 to 5 kilograms in weight have been used. In the arterial experiment either given by the open method was used as the anæsthetic but it was soon found and proved to be able to adopt the method of intratracheal insufflation of ether using Palmer's ideal respiration pump.

Blood pressure. The systemic blood pressure was recorded by means of a mercury manometer connected to a cannula inserted into the femoral artery usually on the right side. A cannula inserted into the femoral vein of the other side permitted such intra-venous injection as was required to be made.

Respiration. Various methods of recording the respiration were used such as Gunn's stethograph (*2*). For reasons which will become apparent the latter part of the paper in method which involves recording the movement of the thoracic wallmeniscus discarded in favour of which enables variations in the intrathoracic negative pressure to be recorded. For this purpose two glass tubes one long and one short were fitted by means of rubber corks to a two-necked 11½ litre bottle of a capacity of 12 litres. The long tube three-fourths filled with water. To the long tube the hopned 11½ litre bottle the surface of the water in the bottle a short thin walled metal tube was connected by means of rubber tubing. The other extremity of the metal tube was fastened to a bevelled end. The short glass tube was similarly connected to a delicate tambour. A small incision was made through the skin and the passage over an intercostal space a distance of the bevelled end of the metal tube inserted. By means of a pursestring suture the

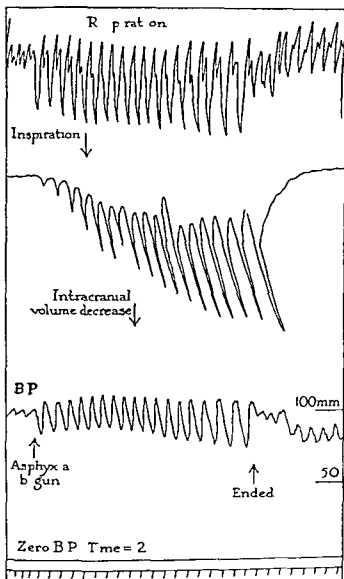


FIG. 1. The uppermost line represents the changes in negative pressure in the thorax, lowering of pressure in inspiration causing the lever to move downward. The middle section records changes in intracranial volume reduction causing the lever to descend. The next part corresponds to the systemic blood pressure. Below this are two lines, the upper giving the level of zero blood pressure and the lower intervals of time corresponding to 2 seconds. The figures at the right hand side correspond to the height at which the blood pressure recorder would stand for definite levels of pressure. Asphyxia is used as a convenient abbreviation for occlusion of the tracheal cannula. These observations apply *in toto* to all further tracings and no further repetition of these remarks will be required. So far as possible in this and all other tracings the various lines have been so arranged that vertical lines drawn from top to bottom would show synchronous changes in each line.

On commencement of asphyxia there are immediately large changes in intrathoracic pressure. Similarly the intracranial volume becomes unusually steady, shows rapid movements growing more pronounced and at the same time there is an increasing lowering of the point to which it returns, increasing to a maximum. The blood pressure remains generally steady although the respiratory waves are greatly enlarged. At the end of asphyxia

skin was drawn closely around the tube to form an airtight joint. The tube was then thrust through the intercostal muscles so producing a connection between the pleural cavity and the Woulfe's bottle. Any variation in the pressure within this cavity will cause the water in the long tube to rise or fall which in turn will abstract from or add to the water in the Woulfe's bottle and so vary the pressure in the air space above the water. The tambour will be affected by the variation in pressure and the lever will fall with a decrease and rise with an increase of intrathoracic pressure. Given a sufficiently large tambour it would be possible to connect the intrapleural cavity direct to the tambour but the changes of pressure are so great that the size of tambour required would be quite impracticable. The Woulfe's bottle inserted into the system to reduce the pressure variations to be recorded and the size of the tambour required. The larger the amount of water in the bottle the larger will be the movements of the tambour lever for any given change of intrapleural pressure and vice versa.

BRAIN FLAP. To obtain records of the variations of intracranial volume which form the subject of this paper the temporal muscle on one side usually the left was reflected and a hole cut in the parietal eminence by means of a trephine centimeters in diameter. Care was taken to avoid damaging the dura mater and twice only in the whole series of experiments did such injury occur. Sometimes there was severe hemorrhage from the diploe which was controlled by means of a piece of muscle and pressure. When bleeding had ceased an instrument made specially for this purpose was inserted into the opening. This was made for us by Mr. I. Rice late of the Physical Department of the Egyptian Ministry of the Interior to whom we desire to express our gratitude. A piece of brass 3.5 centimeters in diameter was turned down at one end to a diameter of 7 millimeters. The other end was fashioned into a cone of the exact dimensions of the hole left by the conical trephine. A flange of the full diameter of the brass was left at a distance of millimeters from this end. The conical portion was bored out to an internal diameter of 16 millimeters and on the outer conical surface a fine but deep screw thread was turned. A hole 5 millimeters in diameter was then drilled from the narrow end to join that from the wide end. This instrument was screwed into the opening in the skull and to insure an airtight joint a strip of vaselined gauze was wound between the skull and the flange round the junction of brass and bone. Connection was then made by means of rubber tubing to a volume recorder made by Messrs. Palmer of such delicacy that a change of intracranial volume of one tenth of a cubic centimeter caused a movement of the writing point on the surface of the drum of 2 centimeters of arc.

There is an almost complete cessation of the movements of the volume lever and the original level is rapidly re-attained. The respiratory movements remain large on account of the previous deprivation of oxygen.

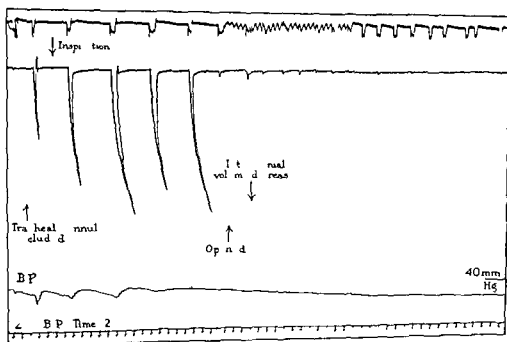


FIG. 4. A tracing from a moribund dog in which respiration took the form of gasps. The immediate appearance and disappearance of brain flap on occlusion and release of the tracheal cannula are characteristic. The synchronicity of the movements of the volume and respiration levers is well marked.

ment of changes in diameter or volume of the chest or abdomen.

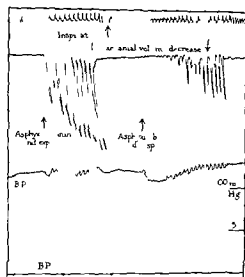
Division and stimulation of the vagus. Another method of demonstrating the close association between brain flap and respiration was sought. If one vagus nerve be divided in the neck, the other being left intact, stimulation of the central end of the cut nerve will cause cessation of respiration with little or no accompanying change in the systemic blood pressure. Brain flap was induced in an animal and when the movements of the intracranial volume lever were pronounced stimulation with the faradic current of the central end of the cut vagus was commenced. At once the movements of the lever recording volume and respiration ceased. Immediately the stimulus was stopped they recommenced. This is displayed in the tracing reproduced as Figure 2. If both vagi are divided, stimulation of the central end of one causes a considerable rise of the systemic blood pressure, due to stimulation of the vasomotor center alone, without the concurrent depressor reflex which will be present if one nerve is left intact. In consequence the results obtained under these conditions are of less value, as will be more readily appreciated when the experiments described in the next section of the paper are considered (Fig. 3).

Gasping. Figure 4 is a reproduction of a tracing obtained from a moribund dog. In this animal respiration consisted only of a series of gasps. While the air entry was impeded the movements of the levers recording variations in intracranial volume and respiration respectively will be seen to be exactly synchronous, both moving downward with inspiration and upward with expiration. When the obstruc-

tion to respiration was removed there was a short period of more rapid respiration soon followed by a recurrence of gasping. It will be observed that though the movements of brain flap are well marked while the tracheal cannula is blocked, they cease at once on the removal of the obstruction to air entry and do not recur with the reappearance of gasping.

Association of brain flap and respiratory movements with inflated or deflated chest. Another type of experiment was performed to demonstrate the dependence of brain flap on a further decrease of the normally negative intrathoracic pressure. Figure 5 is a reproduction of a tracing which may be divided into two parts. In the first the tracheal cannula was occluded when the chest was at its smallest volume at the commencement of inspiration. When the cannula was closed the pressure changes in the pleural cavity were immediately greatly increased, the negative pressure becoming more negative with inspiration. Brain flap appeared at once, the movements of the lever being practically at their maximum from the beginning. In the second part, however, the air entry to the lungs was cut off with the chest distended at the end of inspiration. Under these conditions a period of time elapsed before the changes in intrapleural pressure with respiration became much increased. At the same time as can be seen from the tracing, brain flap began at once but the movements were very much less marked, being very small at first and gradually increasing to about half the size of those obtained in the earlier part of the tracing.

Stimulation of the phrenic nerves. It was thought that information might be gained from the results of artificially induced movements of the diaphragm



I s T d m t t l e l t h p t w n t r
 p t p h a w m m c d t t h e d t p r a t n
 t h m n t f b t h t p t n a d l m l
 a r l y m m a l t b k w t h t h s d p t
 t h y a b g n t t h d f p r a t T h m o
 m t f b t h l e m a l l t b n t h p a d l l y
 g w l a j l t t t a n t h f t h t h
 h t p t t h p r a t r y t a g w m a d t h s t h
 g p h t h p r m t t h l r m p d w t h
 j r a t

The phrenic nerve isolated in the neck on both
 sides. This is not as in the dog as the nerves arise
 as branches of the brachial plexus of the cervical plexus.
 Because of this it is usually impossible to isolate
 more than a pair perhaps two thirds of the nerve
 without the risk of injury to the pleura or great vessels.
 The nerve is then stimulated simultaneously
 with the electroplectic in series so as to insure
 the carrying of the maximum amount of current by both
 nerves. The type of stimulation employed
 is the short sharp and long faradizations. The
 transcranial annular as occluded for but only just
 below the maximum amount of the stimulus.

Figure 6 shows the result of varying faradization.
 There is an immediate drop of about 10 mm Hg
 of intracranial pressure accompanied by a
 small amount of intracranial pressure. As it was
 impossible to isolate a little more of the whole nerve
 it was impossible to obtain a transverse contraction
 of the whole diaphragm. Consequently a small
 amount of both followed the first big movement.
 It will be noted that the intracranial
 pressure although not remaining at its minimum
 point is not returning to its original size until the
 stimulation has ended. This probably is due to
 the fact that the stimulation causes the diaphragm
 to remain in part contracted. During the period
 of stimulation the arterial blood pressure rose but
 then the respiratory pressure superposed on the
 transcranial pressure obtained from stimulation

of the nerves with single shocks but short periods
 of faradization yielded tracings similar to the one
 already described.

The results of Figure 7 taken from a tracing
 recorded on a rapidly moving drum and permits a
 closer analysis of the time relations between the
 movements of the lungs and the changes in the
 intracranial volume and in intrathoracic pressure
 respectively. Careful measurement showed that the
 pressures reached their lowest points simultaneously.
 On the other hand the commencement of these
 movements were not synchronous with the intrathoracic
 pressure being considerably lowered before any
 change in the intracranial volume could be detected.
 The pressure phases however are closely parallel
 to one another with some tendency for the restoration
 of the normal of the intracranial volume to precede
 that of intrathoracic pressure. Other tracing
 have been similarly analyzed. The only appreciable
 difference between the findings in these and the find-
 ings already reported is that the pressure may be high in
 the position of the maximum decrease of intra-
 cranial volume as compared with that of intrathoracic
 pressure. This was more noticeable in the cases in
 which the movements obtained were very large and im-
 probable and very probably instrumental in origin due to the inertia of the measuring lever.

Influence of Intracranial Pressure

At first it was generally found that at the begin-
 ning of an experiment even the most vigorous in-
 spiratory movement coupled with considerable resistance
 to air entry produced only very small movements
 of the lever recording changes in intracranial
 volume or even none at all. Occasionally there might
 be a few millimeters of the lever scale smaller than
 its predecessor and the whole device rapidly
 although the resistance to breathing was still main-
 tained (Fig. 8).

On the other hand after the experiment had been
 in progress for some time it was usually possible
 to induce quite large movements of the intracranial
 pressure using the method apparently exactly the same as
 those which had previously failed. In the first case
 the animal was in good condition with no mal blood
 pressure. In the second the result of the operation
 itself had not impaired its condition with usually
 but by no means a lessened blood pressure.
 It was thought therefore that one of the essential
 factors was a lowering of the systemic blood pressure.

The method used. The method employed to test
 the hypothesis as to stimulate the peripheral
 end of a uterine nerve during a period of respira-
 tory apnoea with the transcranial block. Ex-
 periments were performed on these lines and a tracing
 from one is reproduced as Figure 9. From this
 it will be seen that closure of the tracheal canula
 produced small movements of the brain flap exactly
 similar to those shown in Figure 8. When the animal
 ceased the peripheral end of the cut vagus nerve was
 stimulated with the electrode cut. The blood
 pressure fell at once to about half its previous height

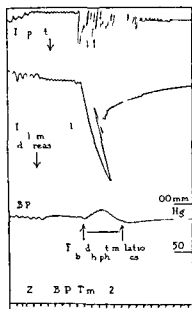


Fig 6

Fig 6 To show the result of simultaneous fall of both phrenic nerves. A rapid diminution of intracranial volume occurs simultaneously with a similar diminution of intrathoracic pressure caused by the sharp descent of the diaphragm.

Fig 7 This tracing was taken on a rapidly moving drum to permit analysis of the time relationships between the movements of the respiratory and volume levers.

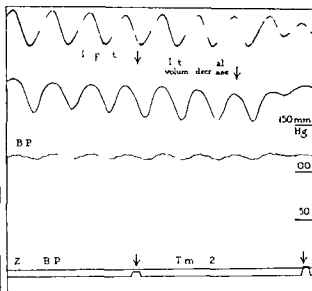


Fig 7

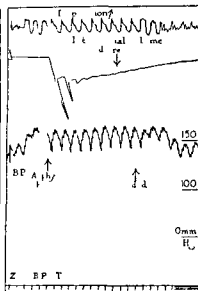


Fig 8

Fig 8 This shows the type of brain flap which occurs occasionally at the commencement of an experiment. Coincident with the commencement of asphyxia there is a sharp fall of the volume lever but with each successive respiratory movement the extent of the excursion of the volume lever is less the whole dying away rapidly. This occurs in spite of the continuance of the resistance to breathing.

and as promptly recovered on the cessation of the stimulation. No sign of brain flap was observed either during or after the period of stimulation. The

whole experiment was then repeated with similar results.

The effect of histamine. Another possibility was that brain flap does not occur without the coexistence of some degree of shock. Undoubtedly the combination of anæsthetic operative interference exposure etc. would be likely to cause this condition which was probably always present to a greater or less extent after an hour had elapsed from the commencement of the experiment at about which time brain flap commonly made its appearance.

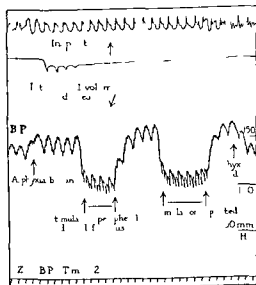


Fig 9 This tracing shows to commence with a few movements of the volume lever exactly similar to but smaller than those in the preceding figure. When these had ceased the peripheral end of the cut left vagus was faradized. The blood pressure fell considerably but although the tracheal cannula was blocked the e were no signs of brain flap. A repetition of the experiment was also without result. In this tracing the respiratory lever moves upward in inspiration.

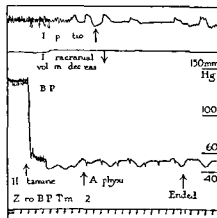
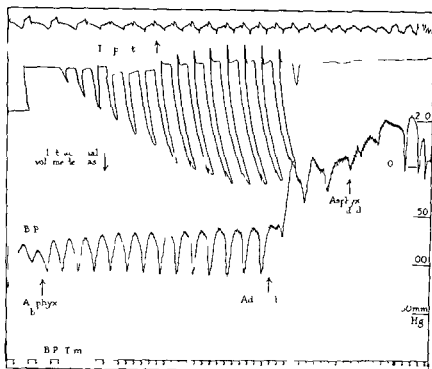


Fig 10 To show the result of the injection of histamine. The usual profound fall of blood pressure occurred but in spite of vigorous inspiratory movements no trace of brain flap could be seen. The respiratory tracing was taken with a stethograph the lever moving upward in inspiration.



T r B fl p h l e d d by phv bo t mll g m f
 l e l w j e t d t a l y Th xpect d e f bl d p s
 a l w t t t h a m p l t t f b n l f R s p t d d
 l y t h t t i g p h

Again in this case, especially and indicated, a sharp shock must have been present often in a very marked degree.

To imitate surgical shock, small doses of 1/2 m. mephosphate (about 1 milligram) were injected intravenously early in the experiment. The attempts to produce a sharp fall in blood pressure of the tracheal cannula had already been found to fail. A tracing produced in Figure 10 shows the heart rate to permit a less or fall of systolic blood pressure. The high frequency intravenous administration of the drug. At the same time, occlusion of the tracheal cannula produced not the faint tracing of brain flap. The method of intravenous administration of the condition, a faint but distinct tracing of the intravenous small dose of 1/2 m. mephosphate (about 1 milligram). The usual immediate response is a fall in blood pressure of 5 or 100 milligrams of mercury. When the immediate fall of the drug has passed off, the blood pressure falls to a level that is slightly below the normal level. It was then found that in animals in which the endogenous level of the intravenous administration of the tracheal cannula, brain flap was rarely produced by the method and that the duration of the fall might be very large. Figure 11 shows a tracing produced to show the response. After the animal became insensitive

to this treatment for some time usually until the end of the experiment. Occasionally, the response is a faint or no response.

The following is a summary of the results. The first series of experiments was conducted with the tracheal cannula. The second series of experiments was conducted with the tracheal cannula. The third series of experiments was conducted with the tracheal cannula. The fourth series of experiments was conducted with the tracheal cannula. The fifth series of experiments was conducted with the tracheal cannula. The sixth series of experiments was conducted with the tracheal cannula. The seventh series of experiments was conducted with the tracheal cannula. The eighth series of experiments was conducted with the tracheal cannula. The ninth series of experiments was conducted with the tracheal cannula. The tenth series of experiments was conducted with the tracheal cannula. The eleventh series of experiments was conducted with the tracheal cannula. The twelfth series of experiments was conducted with the tracheal cannula. The thirteenth series of experiments was conducted with the tracheal cannula. The fourteenth series of experiments was conducted with the tracheal cannula. The fifteenth series of experiments was conducted with the tracheal cannula. The sixteenth series of experiments was conducted with the tracheal cannula. The seventeenth series of experiments was conducted with the tracheal cannula. The eighteenth series of experiments was conducted with the tracheal cannula. The nineteenth series of experiments was conducted with the tracheal cannula. The twentieth series of experiments was conducted with the tracheal cannula. The twenty-first series of experiments was conducted with the tracheal cannula. The twenty-second series of experiments was conducted with the tracheal cannula. The twenty-third series of experiments was conducted with the tracheal cannula. The twenty-fourth series of experiments was conducted with the tracheal cannula. The twenty-fifth series of experiments was conducted with the tracheal cannula. The twenty-sixth series of experiments was conducted with the tracheal cannula. The twenty-seventh series of experiments was conducted with the tracheal cannula. The twenty-eighth series of experiments was conducted with the tracheal cannula. The twenty-ninth series of experiments was conducted with the tracheal cannula. The thirtieth series of experiments was conducted with the tracheal cannula. The thirty-first series of experiments was conducted with the tracheal cannula. The thirty-second series of experiments was conducted with the tracheal cannula. The thirty-third series of experiments was conducted with the tracheal cannula. The thirty-fourth series of experiments was conducted with the tracheal cannula. The thirty-fifth series of experiments was conducted with the tracheal cannula. The thirty-sixth series of experiments was conducted with the tracheal cannula. The thirty-seventh series of experiments was conducted with the tracheal cannula. The thirty-eighth series of experiments was conducted with the tracheal cannula. The thirty-ninth series of experiments was conducted with the tracheal cannula. The fortieth series of experiments was conducted with the tracheal cannula. The forty-first series of experiments was conducted with the tracheal cannula. The forty-second series of experiments was conducted with the tracheal cannula. The forty-third series of experiments was conducted with the tracheal cannula. The forty-fourth series of experiments was conducted with the tracheal cannula. The forty-fifth series of experiments was conducted with the tracheal cannula. The forty-sixth series of experiments was conducted with the tracheal cannula. The forty-seventh series of experiments was conducted with the tracheal cannula. The forty-eighth series of experiments was conducted with the tracheal cannula. The forty-ninth series of experiments was conducted with the tracheal cannula. The fiftieth series of experiments was conducted with the tracheal cannula. The fifty-first series of experiments was conducted with the tracheal cannula. The fifty-second series of experiments was conducted with the tracheal cannula. The fifty-third series of experiments was conducted with the tracheal cannula. The fifty-fourth series of experiments was conducted with the tracheal cannula. The fifty-fifth series of experiments was conducted with the tracheal cannula. The fifty-sixth series of experiments was conducted with the tracheal cannula. The fifty-seventh series of experiments was conducted with the tracheal cannula. The fifty-eighth series of experiments was conducted with the tracheal cannula. The fifty-ninth series of experiments was conducted with the tracheal cannula. The sixtieth series of experiments was conducted with the tracheal cannula. 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The seventy-third series of experiments was conducted with the tracheal cannula. The seventy-fourth series of experiments was conducted with the tracheal cannula. The seventy-fifth series of experiments was conducted with the tracheal cannula. The seventy-sixth series of experiments was conducted with the tracheal cannula. The seventy-seventh series of experiments was conducted with the tracheal cannula. The seventy-eighth series of experiments was conducted with the tracheal cannula. The seventy-ninth series of experiments was conducted with the tracheal cannula. The eightieth series of experiments was conducted with the tracheal cannula. The eighty-first series of experiments was conducted with the tracheal cannula. The eighty-second series of experiments was conducted with the tracheal cannula. The eighty-third series of experiments was conducted with the tracheal cannula. The eighty-fourth series of experiments was conducted with the tracheal cannula. The eighty-fifth series of experiments was conducted with the tracheal cannula. The eighty-sixth series of experiments was conducted with the tracheal cannula. The eighty-seventh series of experiments was conducted with the tracheal cannula. The eighty-eighth series of experiments was conducted with the tracheal cannula. The eighty-ninth series of experiments was conducted with the tracheal cannula. The ninetieth series of experiments was conducted with the tracheal cannula. The ninety-first series of experiments was conducted with the tracheal cannula. The ninety-second series of experiments was conducted with the tracheal cannula. The ninety-third series of experiments was conducted with the tracheal cannula. The ninety-fourth series of experiments was conducted with the tracheal cannula. The ninety-fifth series of experiments was conducted with the tracheal cannula. The ninety-sixth series of experiments was conducted with the tracheal cannula. The ninety-seventh series of experiments was conducted with the tracheal cannula. The ninety-eighth series of experiments was conducted with the tracheal cannula. The ninety-ninth series of experiments was conducted with the tracheal cannula. The hundredth series of experiments was conducted with the tracheal cannula.

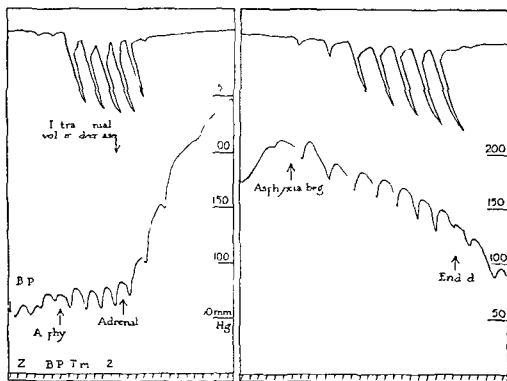


FIG. 12. The first part of this tracing shows the abolition of brain flap by the intravenous injection of adrenalin just as in the left figure. In the second part however it will be evident that at a time when the systemic blood pressure was still at a height above that at which brain flap had previously ceased though below its maximum a phylaxis was all to induce this condition. For exact synchronicity between the volume and blood pressure transients the latter should be transferred one sixteenth of an inch to the left.

Influence of Interference with the Cerebral Circulation

At first attempts were made to examine the results of occlusion of on the one hand the carotid arteries and on the other the external jugular veins the internal in the dog being remarkably small or even absent. No definite results were obtained from this procedure alone. It was thought that this was probably due to the very efficient blood supply afforded by the vertebral vessel. In consequence the method of ligating these vessels was employed which was introduced by Sherrington (9) for the decapitation operation in cats. In this a piece of stout string is passed by means of a packing needle in front of the vertebral column and the end brought out on the dorsal surface of the neck. The muscles of the back and sides of the neck are then divided and the string tightly knotted at the back so that the vertebral vessels are compressed against the spinal column.

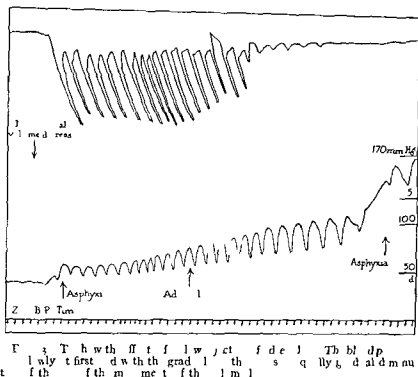
Occlusion of the carotid arteries. After both arteries had been freed from the other structures contained in the sheath a ligature was passed loosely round each in such a manner that when the ends were pulled the lumen of the vessel would be obliterated without at the same time any risk of damaging its coats. On release of the ligature the blood supply to the brain was instantly restored. The natural result

of occluding these arteries after the vertebral vessels have been tied is to stimulate the vasomotor center by the resulting anemia of the medulla and so to cause a rise of blood pressure. This in fact did not always occur probably because of the extensive anastomoses described by Hill (3) between the intercostal and spinal arteries.

After the experimental animal had been rendered sensitive to occlusion of the tracheal cannula the air entry was checked and as soon as brain flap was established the carotid arteries were occluded usually simultaneously. The result in most cases was a fall in intracranial volume coupled sometime with an increase in the size of the excursions of the lever. On releasing the ligatures there was a rapid increase in the intracranial volume together with a reduction or abolition of brain flap (Fig. 14).

Sometimes but not in this case the volume lever ultimately reached a level higher than that at the beginning of the experiment showing that the intracranial volume had undergone some more or less permanent increase.

It will be noticed that the arterial blood pressure rose to nearly 100 milligrams of mercury while the movements of brain flap were still very large. This does not in any way antagonize the statements made that the action of adrenalin in causing a rise of blood pressure prevents or stops the development



flora ship Here the high blood pressure was continuous to the extracranial part of the body and could not reach the cranium except through the spinal cord and any others which might assist most with the cerebral vessels. The great effect of blood pressure alone suggests that there can have been only a inefficient anastomosis of the blood vessels to the spinal cord. It has been the stimulation of the spinal cord.

On the jugular veins The jugular vein was compared in a manner similar to the cerebral arteries. The result of the occlusion of the jugular vein which the vertebral vessels have in the brain and brain flap, decided by the occlusion of the jugular vein was to cause an increase in the intracranial volume and gain a reduction of the amplitude of the curve of the level. On the level of the jugular vein the latter increased in size and the curve might be a reduction of intracranial volume though this was not invariable (Fig. 5). The same case as in the jugular vein rise of systolic blood pressure occurred during the occlusion of the jugular vein in the condition the fall of intracranial volume resulted with the usual as usually absent.

Influence of the loss of the extracranial pressure

Wells and M. Kahlen (11) were the first to observe that the loss of the strongly hypertonic solution of 30 per cent sodium chloride and of hypotonic distilled water were followed by a great decrease and increase respectively.

the venous pressure of the cerebral fluid in the cranium. The investigations have been repeated and confirmed by many other workers.

Experiments were performed with the method in an attempt to discover what relation if any might exist between the intracranial pressure and brain flap. It was found however that some other complications were introduced into the subject that the part of the work would be of little value to a second paper. It is sufficient to present the results that the large movement of brain flap can be the result of this work. The result of the injection of hypertonic solutions.

Other Experimental Observations

So far the description of the experimental work has been practically confined to the rapidly occurring changes in the intracranial volume which are followed by a better name brain flap which is induced by and follows closely on the rapid volume change of a trephined animal in which a tube to the lungs is placed.

But these other rather gross changes in the intracranial volume have been observed to occur. Referring to Figure 1 and will show that in addition to the condition of brain flap there is a second variation. At first there was a progressive lowering of the point to which the level returned on each inspiration until a maximum was reached. This shows that the loss of the inspiration of the intracranial volume was not entirely made up by each expiration and that the pressure during the obstruction to breathing was removed.

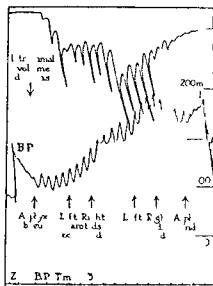


Fig. 14 To show the effects of occluding the carotid arteries the vertebral being already ligated. When asphyxia was started there was a small red change in intracranial volume. When this had reached a steady level the two carotids were occluded. No change followed the block in the first but on closure of the second there was a further diminution of intracranial volume with an increase in size of the brain flap excursions. On release of one artery the intracranial volume began to increase and on release of the second this became more rapid and was associated with an almost complete cessation of brain flap. The rise of systemic pressure is due to anemia of the motor center in the medulla. The blood pressure tracing should be transferred one eighth of an inch to the left to obtain synchronicity with the volume record.

Adrenalin has already been stated causes the movements of brain flap to cease. Not only does it do this but usually causes in addition the intracranial volume to increase.

Although no change of intracranial volume is shown in Figure 10 following the injection of histamine a diminution usually occurred and might be large. On one occasion it was very well marked the volume and blood pressure recorders falling almost parallel to one another.

On a few occasions over vigorous artificial respiration by the pump has caused in a sensitive animal the inverse of brain flap. In this there has been an increase in the intracranial volume with each positive (inspiratory) stroke of the pump. When the pump was disconnected from the tracheal cannula there was a prompt cessation of these movements and a reduction in intracranial volume. Further when the tracheal cannula was blocked true brain flap was produced the intracranial volume falling with each inspiratory movement.

Figure 16 has been prepared to show the results of forcible compression of the heart in the dead animal. Immediately after death the chest was opened and the heart squeezed vigorously with the hand. Each compression was followed at once by a rise in the intracranial volume succeeded by a return of the lever to the base line on relaxing the grip.

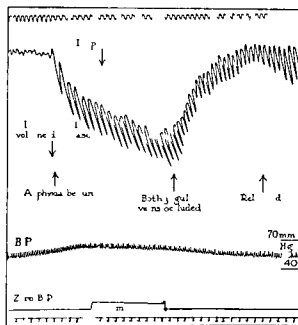


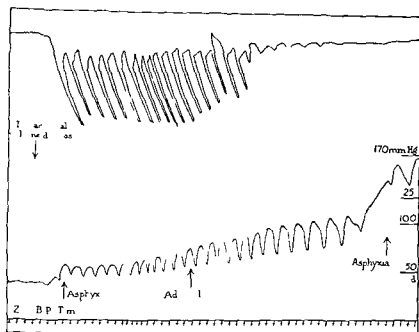
Fig. 15 To show the effect of occlusion of the jugular veins in the carotid ligated animal. Having been previously tied the brain flap having been established the volume was a very large. On occlusion of the jugular veins the intracranial volume fell with a reduction in size of the excursion of brain flap. On release of the vessel the volume immediately became larger but there was no repetition of the volume fall.

A somewhat similar result was given by blowing strongly into the pleural cavity of an animal immediately after death through the tube inserted for the purpose of registering the changes of pressure within that cavity.

DISCUSSION

At the outset it must be emphasized that the clinical observations and experimental results here reported do not and are not intended to represent a state of affairs occurring in the normal condition. The mere fact that the skull has been opened and the dura exposed to atmospheric pressure during the whole course of the observations is at once fatal to any such suggestion. It is in our opinion in the highest degree improbable that any such variations in the cerebral volume as are here described can occur in the animal with an intact skull.

It was suggested by Monroe (6) about 150 years ago that the bony skull could be regarded physiologically as a rigid box and this view has met with general approval. Except in so far as there may be a possibility of forcing cerebrospinal fluid for a very short



l g 3 T sh w th ff t f l w j t f d l Th bl dp
l wly t first d v th th grad l r th s l lly grad l d m
t n f th s f th m m ts f th l m l

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u m e t h u g h t h a n i n t a r i a b l e (F g 5) I
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l m e o l s e f t h l g a t u e s a s u s u a l l y a b e n t

*I flit e f Varant ns the Int ac ual
P es re*

W and M Kibbi (11) are the first to observe that intracellular junctions of strongly hypertonic solution such as 30 per cent sodium chloride and of hypotonic fluid such as distilled water were followed by a gradual decrease and increase respectively.

tive in the pressure of cerebrospinal fluid in the cisterna magna. These investigations have been repeated and confirmed by many other workers.

OH Feb 19 1918 Obs 741 0 15

Since the description of the experimental work has been practically confined to the rapidly occurring local and transient changes in the tracheal volume called the effect, the lack of a better name brain flap which is induced by and follows closely on the respiratory movements of a tracheotomized animal in which a respiratory plug is prevented.

Besides the other gross changes in the intra-anal volume have been observed to occur. Reference to Figures 1 and 5 illustrates that in addition to the condition of brain flap there is a secondary variation. At first there was a progressive lowering of the point to which the letter returned on each expiration until a maximum was reached. This shows that the latter was on inspiration of the intra-anal volume as not entirely made up the chest pressure and that this persisted until the obstruction to breathing was removed.

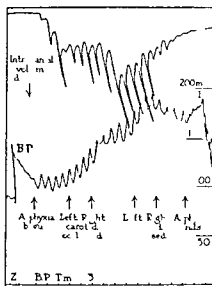


FIG. 14. To show the effects of occluding the carotid arteries the vertebral being already ligated. When asphyxia was started there was a small ejection in intracranial volume. When this had reached a steady level the two carotids were occluded. No change followed the blocking of the first but on closure of the second there was a further diminution of intracranial volume with an increase in size of the brain flap excursions. On release of one artery the intracranial volume began to increase and on release of the second this became more rapid and was associated with an almost complete cessation of brain flap. The rise of systemic pressure is due to anemization of the vasomotor center in the medulla. The blood pressure tracing should be transferred one eighth of an inch to the left to obtain synchronicity with the volume record.

Adrenalin as has already been stated causes the movements of brain flap to cease. Not only does it do this but usually causes in addition the intracranial volume to increase.

Although no change of intracranial volume is shown in Figure 10 following the injection of histamine a diminution usually occurred and might be large. On one occasion it was very well marked the volume and blood pressure recorders falling almost parallel to one another.

On a few occasions over vigorous artificial respiration by the pump has caused in a sensitive animal the inverse of brain flap. In this there has been an increase in the intracranial volume with each positive (inspiratory) stroke of the pump. When the pump was disconnected from the tracheal cannula there was a prompt cessation of these movements and a reduction in intracranial volume. Further when the tracheal cannula was blocked true brain flap was produced the intracranial volume falling with each inspiratory movement.

Figure 16 has been prepared to show the results of forcible compression of the heart in the dead animal. Immediately after death the chest was opened and the heart squeezed vigorously with the hand. Each compression was followed at once by a rise in the intracranial volume succeeded by a return of the lever to the base line on relaxing the grip.

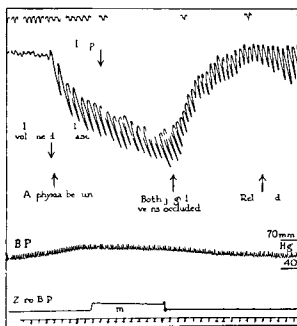


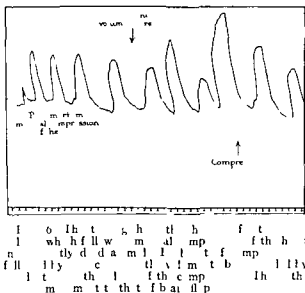
FIG. 15. It shows the effect of occlusion of the jugular veins the vertebral being previously tied. Brain flap has in the meantime been established there was a very large reduction of intracranial volume. Occlusion of the jugulars was followed by a prompt return of the intracranial volume to its normal level with a reduction in size of the excursions of brain flap. On release of the vessel the volume movements became larger but there was no repetition of the general fall of level.

A somewhat similar result was given by blowing strongly into the pleural cavity of an animal immediately after death through the tube inserted for the purpose of registering the changes of pressure within that cavity.

DISCUSSION

At the outset it must be emphasized that the clinical observations and experimental results here reported do not and are not intended to represent a state of affairs occurring in the normal condition. The mere fact that the skull has been opened and the dura exposed to atmospheric pressure during the whole course of the observations is at once fatal to any such suggestion. It is in our opinion in the highest degree improbable that any such variations in the cerebral volume as are here described can occur in the animal with an intact skull.

It was suggested by Monroe (6) about 150 years ago that the bony skull could be regarded physiologically as a rigid box and this view has met with general approval. Except in so far as there may be a possibility of forcing cerebrospinal fluid for a very short



distance along the nerve sheaths as they issue from the skull it would seem that there can be no change in volume of the total intracranial contents and that such changes as are here described could never occur so long as the bony cranium remains intact.

Under the conditions of experiment as here described it is clear that the dura mater may on the one hand fall into a considerable extent and on the other bulge outward slightly until the limit of elasticity of the membrane is reached. It is with such changes in volume occurring very rapidly that we are concerned.

In the first place we have to consider which substance of those present within the skull can undergo such rapid changes. It is inconceivable that the solid matter, the gray and white matter of the brain can change in volume with such rapidity. There is little room for doubt that the cerebrospinal fluid secreted by the choroid plexus and absorbed into the veins through the pachionian bodies may vary in volume from time to time. It is however in the highest degree improbable that the processes of absorption and secretion should take place with the rapidity of the movements of brain flap and that they should have when present that time relationship with the respiration which is also characteristic of brain flap.

There remain the content of blood within the skull. This quantum whatever it may

actually be from its nature as part of the blood in general circulation is eminently variable. The tracing shown as Figure 16 shows clearly that changes of intracranial volume may be due to variations in the blood content. On compression of the heart immediately after death the volume lever attached to the skull rose and on relaxation of the compression it fell to its original level. Here there can be little doubt that compression of the heart had forced blood back through the practically valveless great veins (3) of the neck into the cranial cavity. There was no complication due to respiration, artificial or natural to confuse the issue. Although it is true that the movement shown in the tracing is the exact inverse of that seen in brain flap this is of no importance. The tracing shows that variations of blood volume in the cerebral circulation can produce marked changes in intracranial volume.

We may conclude then that brain flap is dependent on variations of the content of blood within the skull. We have now to consider what factors are or may be concerned in the production of these variations. The volume of blood within the skull from moment to moment must depend on the relative rates of inflow and outflow. There are three possible conditions that in which the inflow equals is greater than or is less than the outflow.

In the first case the quantity of blood in the skull will remain constant and there will be no brain flap. This is the usual condition unless special measures are taken to upset the balance between inflow and outflow.

In the second condition with inflow greater than outflow there will be a tendency for the intracranial tension to rise and this will be displayed under the experimental condition by a bulging of the dura mater through the trephine opening with a rise in the volume lever. This was found to take place in an experiment in which all exit of flow from the skull was prevented while the carotid arteries remained open. This was done by temporary occlusion of the jugular veins the vertebral vessels having been previously tied (Fig 15). No brain flap will arise from this procedure alone.

In the third case with inflow less than outflow there will be a tendency for the intracranial pressure to fall and under our experimental conditions this will appear as a sinking in of the dura mater and a fall in the volume lever. This was found to be the case when the carotid arteries were temporarily blocked after the vertebral vessels had been tied (Fig. 14). This *by itself* will not give rise to brain flap.

The condition of brain flap is characterized by a rapid alternation of the condition present in the second and third cases, a rapid fall and rise of the volume lever, the excursion of the lever in each direction being equal or nearly so with a tendency for the upward movement to be less than the downward. This may be stated as a rapid alternation of short periods of time in which inflow is less and greater than outflow.

We will next consider the condition governing the flow of blood into and out of the cranial cavity. On the side of inflow there is the systemic blood pressure opposed by the resistance of the arterioles and capillaries. To cause outflow there is the venous pressure, practically the resultant of the two former forces, aided or opposed by the change in intrathoracic pressure during inspiration and expiration. At the same time it should be remembered that the whole intracranial circulation is subject to the almost constant pressure of the cerebrospinal fluid, a pressure of the same order as and varying slightly in either direction from that in the veins (1).

If the experimental observations are considered it will be clear that they may be divided into two groups, those in which brain flap did and did not appear respectively. It may be observed here that in most respects there was no difference in the experimental procedure employed in both cases. The former group will be considered first.

In all the experiments in which brain flap was produced there was only one constant factor, excessive aspiration by the thorax. Hyperpnoea alone, even when very vigorous, was not sufficient to induce the condition (Fig. 1). Hyperpnoea if the entry to the lungs be perfectly free, as it is with a large, bored tracheal cannula, will produce but

little change in the intrathoracic pressure and so little change in the aspirating action of the chest in inspiration on the blood contained in the thin walled great veins. On the other hand if the lungs cannot follow freely the movement of the chest wall in inspiration, the pressure in the pleural cavity will be greatly reduced and the aspirating effect correspondingly increased. If then the tracheal cannula be blocked at the end of expiration, the result of even normal breathing will be to cause considerable diminution of the intrapleural pressure on inspiration with a return to the previous pressure on expiration. This will produce a great increase in the aspirating effect during inspiration and a rapid decrease during expiration. This should, under the right conditions, does induce that type of brain flap in which the movement is large from the beginning (Fig. 5, the first part). Again it would be expected that if the tracheal cannula be blocked at the end of inspiration there would be less tendency for the intrapleural pressure to be further reduced with succeeding inspirations until on the one hand accumulation of carbon dioxide in the blood caused the respirations to become deeper and on the other the continued abstraction of oxygen by the blood from the lungs had reduced their volume and the intrapleural pressure. Under the right conditions brain flap in which the movements should be small at first and gradually increase in size would thus be produced (see Fig. 5).

Stimulation of the phrenic nerves on both sides simultaneously leads to a sharp descent of the diaphragm and with the tracheal cannula blocked to a sudden diminution of intrathoracic pressure. Experiment showed again that this diminution with its aspiratory effect produced an equally rapid reduction of brain volume (Fig. 6).

Even more conclusive proof of the dependence of brain flap on respiration was obtained by those experiments in which the central end of one vagus was stimulated, the other nerve being left intact (Fig. 7). While brain flap was being maintained as a result of occluding the tracheal cannula, stimulation of the nerve was commenced. This caused respiration to cease during the period of stimulation. Brain

flap ceased with the cessation of respiration and recommenced with the respiration on the termination of the period of nerve stimulation. Here there was only one difference between the periods with and without brain flap, the fact that the respiration and with it the aspirating effect of the thoracic movements had ceased. The blood pressure remained practically constant throughout.

Consideration of the time relations between the movements of the intracranial volume and of the intrathoracic pressure levers (Figs 4 and 7) shows that both reach their lowest points simultaneously. This means that the maximum diminution of intracranial volume occurs at the same moment as the maximum reduction of intrapleural pressure or the maximum aspirating effect. This confirms the dependence of brain flap on this action of the thorax. At the same time it disproves the suggestion which might be made that these changes in intracranial volume are the result of exaggerations of the normal respiratory wave found in the arterial blood pressure tracing. It is true that these waves are exaggerated by the occlusion of the tracheal cannula as would indeed be expected and this may be seen to be the case in Figures 9 and 11. It is however well known that the arterial pressure rises during the last two thirds of the inspiratory phase to reach its maximum at the end of the first third of expiration. Now with a rise in arterial pressure the intracranial volume rise and were brain flap due to an exaggeration of the respiratory waves on the blood pressure there should be an increase in intracranial volume reaching its maximum at a point in close proximity to that at which in fact it is at a minimum.

We have now considered fully the relationship between brain flap and one of the factors concerned in the regulation of the outflow from the cerebral circulation, the aspirating action of the thorax. Little has been said with regard to the damming back of blood which occurs with expiration except in so far as it is responsible for the return of the volume of the cranial content to its previous position. It must be remembered that the dura mater is a very tough inelastic membrane which will offer considerably higher resistance to a

force tending to cause it to expand than will be the case with the thin walled veins. The other factor in connection with the outflow from the brain is the venous pressure. This is so dependent on the arterial blood pressure that it needs no special treatment.

The effect of variation in the resistance to the flow of blood offered by the cerebral arterioles and capillary bed need hardly be considered. It is well known that the arterioles are very badly supplied with smooth muscle fibers. Again Roy and Sherrington (8) have shown that the vessels in experimental animals are devoid of a vasomotor nerve supply. In consequence they will respond only very slightly if at all to the usual agents causing constriction or relaxation of these elements. Roy and Sherrington found that the circulation in the brain was directly determined by the systemic blood pressure.

The relationship between the systemic blood pressure the more important factor concerned with inflow of blood to the cerebral circulation and brain flap must now be considered. This condition has been induced with arterial pressures as measured in the femoral artery ranging from 140 to 40 milligrams of mercury, indicating that there is little connection between the actual height of arterial pressure and occurrence of brain flap.

On the other hand it was found that the great rise of blood pressure caused by the intravenous administration of adrenalin would put a stop to brain flap induced by occlusion of the tracheal cannula although the interference with respiration was still maintained. This suggests that a very high blood pressure is incompatible with brain flap.

Further experiments however showed that when the blood pressure had fallen some what from its highest point but was still above that at which brain flap had previously ceased the condition could again be induced by occlusion of the tracheal cannula. From this it would seem that the mere height of blood pressure is not alone the cause of the cessation of the movement.

In order to arrive at an explanation of these apparently contradictory findings it will be necessary to consider what changes will occur in the cerebral circulation as a result of the

administration of adrenalin. It has been shown that in the animal with the skull intact the effect of adrenalin is to raise the arterial, venous and cerebrospinal fluid pressures (1). Our own experiments show that besides the occlusion of brain flap there is an increase of the volume of the intracranial contents. This must mean that blood is being forced into the skull at a rate greater than that at which it can escape. If blood is already leaving the skull at the maximum possible rate as must be the case under these circumstances aspiration by the thorax cannot increase this rate and in consequence brain flap should cease as in fact it does.

It has been shown by Becht (1) that after the administration of adrenalin the venous pressure rises in the cerebral sinus with the systemic arterial pressure and is maintained at a relatively high level for some time afterward when the latter has fallen considerably. Although the venous pressure remains high the fact that the arterial pressure has fallen points to a diminished inflow of blood. It is the case it is evident that a piration will be able to withdraw blood at a more rapid rate than that of the previous outflow while expiration will check the process. As a result of these two factors brain flap will occur. Further the extent of the movements should increase with a further fall of arterial pressure (see Fig. 1).

Additional support is lent to this argument by the facts recorded in Figure 1. Here adrenalin was injected at first very slowly in dilute solution and later more rapidly. The systemic blood pressure at first rose very slowly and with it the extent of the excursions of brain flap became progressively smaller. As the arterial pressure rose the rate at which the blood entered the sinuses would be increased so that aspiration would have less and less effect thus causing the reduction of brain flap.

To sum up this section of the discussion it may be said that in those cases in which it was possible to induce brain flap experimentally there was one constant feature—excessive aspiration by the thorax produced by blocking partially or completely the air entry to the lung. It seems that up to a

point the height of the arterial pressure has little effect but that once this point is passed the rate of outflow from the skull reaches its maximum and can no longer be increased by a piratory action by the thorax.

So far attention has been confined to those cases in which brain flap was successfully produced by experiment. The very numerous cases in which the condition could not be induced have now to be considered.

In every experiment performed there was at the beginning a period in which even the most vigorous inspiratory movements of the thorax coupled with complete closure of the tracheal cannula failed to produce brain flap. At most and then only rarely a few small movements rapidly becoming smaller and soon disappearing altogether were obtained (Fig. 8). Later on in the experiment we had no such difficulty in one experiment alone did we fail at all times to obtain brain flap.

There can be no question as to the occlusion of the tracheal cannula. The orifices were closed with finger and thumb in the same manner exactly in each case.

Lowering blood pressure by vagal stimulation with complete closure of air entry was entirely without avail. Similarly administration of histamine in order to lower blood pressure and induce a condition closely akin to if not identical with surgical shock was equally useless. The sole result of the latter procedure was not invariably was to cause a reduction of intracranial volume. Again the raising of the blood pressure by the injection of adrenalin was without immediate effect.

In these experiments we attempted to vary the rates of inflow and outflow of the cerebral circulation in all possible ways. Stimulation of the peripheral end of the vagus cause a reduction of blood pressure and also a decrease in inflow with possibly an increase in the venous pressure in the sinuses. Histamine produce a lowering of both arterial and venous pressures in the skull as has been shown by Lee (5). This should produce a reduction of both inflow and outflow. Finally adrenalin as already stated causes an increase in both inflow and outflow.

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As explained in the experimental section the only reliable method of inducing the con

dition was found to be the injection of adrenalin sooner or later after this had been done it would be found that brain flap could be induced. A point of some slight interest is showing the small importance of the arterial pressure in connection with the phenomenon; the fact that in several experiments brain flap was induced some time after the administration of adrenalin with the blood pressure standing at exactly the same figure as that at which it had stood earlier when all attempt to induce brain flap had failed.

It is clear from a comparison of the experiment that failed at first and later were successful that some change must take place in the conditions of the cerebral circulation. At first there is no brain flap or only a very slight manifestation of it which soon disappears. This means that in the normal animal inflow and outflow of blood to and from the cerebral circulation remain exactly balanced however great may be the variations in the respiratory action of the thorax. Later on this balance becomes upset and brain flap develops. The mechanism and nature of this change is at present obscure. There seem however to be three possibilities in this connection. The first is that outflow should be at its maximum to commence with so that a piriation by the thorax cannot further increase the rate of discharge. This seems improbable in view of the facts that first a piriation apart the principal if not the only real factor concerned with the pressure in the innervation of the arterial blood pressure and second at two different times in the same experiment the blood pressure may be exactly the same and yet at one time it may be impossible to induce brain flap and at the other the condition may appear readily. The second possibility is that there may be some as yet unknown mechanism which controls the inflow to make it exactly equivalent to the outflow at all times however much the latter may vary. Nothing is known of such a mechanism and having regard to the circumstances of the cerebral circulation it seems improbable that such should exist. The third possibility is based on the facts that (a) the only certain way of inducing the condition in animal was found to be by the ad-

ministration of adrenalin and (b) it is known that the venous pressure remains high for some considerable length of time after the return of the arterial pressure to the normal. It may be that the arterioles become as it were strained by the passive pressure exerted on them by the systemic blood pressure and remain dilated throughout the experiment thus enabling the venous pressure to remain high with a relatively low arterial pressure.

Again it may be that variations in the intracranial pressure may condition the change in the cerebral circulation. The present experiments in this direction are not sufficiently complete to allow us to say anything on this point and this part of the subject is reserved for a second publication. Hill (3) states that a high intracranial pressure would tend to dump any other variations in pressure or volume within the cranial cavity.

Finally it remains to consider what if any similarity can be traced between the experimental results and the clinical findings.

Our experiments may be divided into three classes: (1) those with no brain flap; (2) those in which brain flap was represented by a few movements of the intracranial volume lever soon vanishing entirely (Figs 8 and 9); and (3) those in which brain flap was easily induced when desired.

The clinical observations may be divided into three exactly similar classes. The absence of references in surgical literature to phenomena of this kind can mean only one of two things—either brain flap is so common as to be unworthy of remark or so rare that it has been observed only on a few occasions. Considering the frequency of trephining as an operation and the rarity with which this condition has occurred in our experience it is clear that the second explanation is correct. Stertorous breathing is frequently associated with the condition for which trephining is performed and yet brain flap is practically unknown. Therefore the ordinary trephine operation in a case in which there is some obstruction to breathing forms an exact parallel to our first class of experimental findings.

The following table summarizes the results of the experiments:

Case	Time	Pressure	Volume	Observations
1	10:00	100	10	No brain flap
2	10:15	100	10	No brain flap
3	10:30	100	10	No brain flap
4	10:45	100	10	No brain flap
5	11:00	100	10	No brain flap
6	11:15	100	10	No brain flap
7	11:30	100	10	No brain flap
8	11:45	100	10	No brain flap
9	12:00	100	10	No brain flap
10	12:15	100	10	No brain flap
11	12:30	100	10	No brain flap
12	12:45	100	10	No brain flap
13	13:00	100	10	No brain flap
14	13:15	100	10	No brain flap
15	13:30	100	10	No brain flap
16	13:45	100	10	No brain flap
17	14:00	100	10	No brain flap
18	14:15	100	10	No brain flap
19	14:30	100	10	No brain flap
20	14:45	100	10	No brain flap
21	15:00	100	10	No brain flap
22	15:15	100	10	No brain flap
23	15:30	100	10	No brain flap
24	15:45	100	10	No brain flap
25	16:00	100	10	No brain flap
26	16:15	100	10	No brain flap
27	16:30	100	10	No brain flap
28	16:45	100	10	No brain flap
29	17:00	100	10	No brain flap
30	17:15	100	10	No brain flap
31	17:30	100	10	No brain flap
32	17:45	100	10	No brain flap
33	18:00	100	10	No brain flap
34	18:15	100	10	No brain flap
35	18:30	100	10	No brain flap
36	18:45	100	10	No brain flap
37	19:00	100	10	No brain flap
38	19:15	100	10	No brain flap
39	19:30	100	10	No brain flap
40	19:45	100	10	No brain flap
41	20:00	100	10	No brain flap
42	20:15	100	10	No brain flap
43	20:30	100	10	No brain flap
44	20:45	100	10	No brain flap
45	21:00	100	10	No brain flap
46	21:15	100	10	No brain flap
47	21:30	100	10	No brain flap
48	21:45	100	10	No brain flap
49	22:00	100	10	No brain flap
50	22:15	100	10	No brain flap
51	22:30	100	10	No brain flap
52	22:45	100	10	No brain flap
53	23:00	100	10	No brain flap
54	23:15	100	10	No brain flap
55	23:30	100	10	No brain flap
56	23:45	100	10	No brain flap
57	24:00	100	10	No brain flap
58	24:15	100	10	No brain flap
59	24:30	100	10	No brain flap
60	24:45	100	10	No brain flap
61	25:00	100	10	No brain flap
62	25:15	100	10	No brain flap
63	25:30	100	10	No brain flap
64	25:45	100	10	No brain flap
65	26:00	100	10	No brain flap
66	26:15	100	10	No brain flap
67	26:30	100	10	No brain flap
68	26:45	100	10	No brain flap
69	27:00	100	10	No brain flap
70	27:15	100	10	No brain flap
71	27:30	100	10	No brain flap
72	27:45	100	10	No brain flap
73	28:00	100	10	No brain flap
74	28:15	100	10	No brain flap
75	28:30	100	10	No brain flap
76	28:45	100	10	No brain flap
77	29:00	100	10	No brain flap
78	29:15	100	10	No brain flap
79	29:30	100	10	No brain flap
80	29:45	100	10	No brain flap
81	30:00	100	10	No brain flap
82	30:15	100	10	No brain flap
83	30:30	100	10	No brain flap
84	30:45	100	10	No brain flap
85	31:00	100	10	No brain flap
86	31:15	100	10	No brain flap
87	31:30	100	10	No brain flap
88	31:45	100	10	No brain flap
89	32:00	100	10	No brain flap
90	32:15	100	10	No brain flap
91	32:30	100	10	No brain flap
92	32:45	100	10	No brain flap
93	33:00	100	10	No brain flap
94	33:15	100	10	No brain flap
95	33:30	100	10	No brain flap
96	33:45	100	10	No brain flap
97	34:00	100	10	No brain flap
98	34:15	100	10	No brain flap
99	34:30	100	10	No brain flap
100	34:45	100	10	No brain flap

Reference to the first section of the paper will show that in our fourth and fifth cases there was a transient appearance of brain flap. The movements were associated with deep respirations but soon disappeared. The two cases may be considered as similar to or even identical with our second class of experimental findings.

Our first and third clinical case—and probably Wheeler's case should be joined to them—displayed movements of the brain associated with difficulty of breathing which continued for some time. They are sufficiently parallel to our third class of experimental findings to permit us to suggest that there must have been similar causes at work in the two conditions. Only one important objection seems possible that in the clinical cases the condition arose apparently spontaneously but in the experimental work only with active interference. This objection we think is not well founded. It is true that in our later experimental work care was taken to block the tracheal cannula completely. This was done to give us a firm basis for our work. In the earlier experiments it was observed that brain flap could be produced by far less vigorous interference with the air entry such as might occur with excessive mucus in the trachea though the movements were then less pronounced. It is of course impossible to say how much or how little resistance there was to breathing in our clinical cases and consequently how much change in the intrathoracic pressure would occur on inspiration. We feel that with the closely parallel results that have occurred in the operating theater and the experimental laboratory we are justified in claiming that we have reproduced in dogs a condition exactly similar to the rare occurrences of brain flap observed clinically.

SUMMARY

1. A phenomenon of extensive changes in intracranial volume synchronous with respiration in man with the experimental production of a similar condition in dogs is described under the term 'brain flap'.

2. In an animal just after death great changes in intracranial volume can be produced after the chest is opened if the heart

is alternately squeezed and relaxed. These changes from the mechanical conditions must be opposite in sign to those of brain flap.

3. The condition is dependent on change in the intracranial content of blood.

4. The volume of a brain which exhibits this condition diminishes with inspiration and increases with expiration.

5. Dyspnoea is a constant factor in its production both clinically and experimentally.

6. In the presence of dyspnoea the condition may occur with systemic blood pressures ranging from 140 to 40 millimeters of mercury.

7. On the other hand dyspnoea may fail to produce it with systemic blood pressures as low as 40 millimeters of mercury.

8. Brain flap is cut short by the marked rise of arterial blood pressure caused by intravenous injection of adrenalin.

9. *Widely* *definitely* brain flap seems not dependent on arterial pressure.

10. The immediate cause of brain flap would appear to be an imbalance between the quantity of blood entering and leaving the cranial cavity from moment to moment.

11. It is certain that one and probably the main factor in this imbalance is the excessive aspiration of blood from the veins by the chest during dyspnoeic respiration. It is probable (a) that a relatively deficient inflow to the cranial cavity from the arterial side may be an essential factor and (b) that while a high pressure of the cerebrospinal fluid will damp the movements of the brain a fall in pressure may permit them to appear.

Much valuable assistance in the experiments was given by Dr K. Samama M.Sc. Ph.D. and the authors wish to acknowledge their debt in a spirit as wholehearted as that which prompted the aid.

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dition was found to be the injection of adrenalin. Sooner or later after this had been done it would be found that brain flap could be induced. A point of some slight interest showing the small importance of the arterial pressure in connection with the phenomenon is the fact that in several experiments brain flap was induced some time after the administration of adrenalin with the blood pressure standing at exactly the same figure as that at which it had stood earlier when all attempt to induce brain flap had failed.

It is clear from a comparison of the experiment that failed at first and later were successful that some change must take place in the conditions of the cerebral circulation. At first there is no brain flap or only a very slight manifestation of it which soon disappears. This means that in the normal animal inflow and outflow of blood to and from the cerebral circulation remain exactly balanced; however great may be the variations in the respirator action of the thorax. Later on this balance becomes upset and brain flap develops. The mechanism and nature of this change is at present obscure. There are, however, at least three possibilities in this connection. The first is that outflow should be at its maximum to commence with so that respiration by the thorax cannot further increase the rate of discharge. This seems improbable in view of the fact that first respiration apart, the principal if not the only real factor concerned with the pressure in the meninges is the arterial blood pressure and could at two different stages in the same experiment the blood pressure may be exactly the same and yet at one time it may be impossible to induce brain flap and at the other the condition may appear readily. The second possibility is that there may be some as yet unknown mechanism which so controls the inflow as to make it exactly equivalent to the outflow at all times; however much the latter may vary. Nothing is known of such a mechanism and having regard to the circumstance of the cerebral circulation it seems improbable that such should exist. The third possibility is based on the facts that (a) the only certain way of inducing the condition in animal was found to be by the ad-

ministration of adrenalin and (b) it is known that the venous pressure remains high for some considerable length of time after the return of the arterial pressure to the normal. It may be that the arterioles become as it were strained by the passive pressure exerted on them by the systemic blood pressure and remain dilated throughout the experiment thus enabling the venous pressure to remain high with a relatively low arterial pressure.

Again it may be that variations in the intracranial pressure may condition the change in the cerebral circulation. At present our experiments in this direction are not sufficiently complete to allow us to say anything on this point and this part of the subject is reserved for a second publication. Hill (3) states that a high intracranial pressure would tend to damp any other variations in pressure or volume within the cranial cavity.

Finally it remains to consider what if any similarity can be traced between the experimental results and the clinical findings.

Our experiments may be divided into three classes: (1) those with no brain flap; (2) those in which brain flap was represented by a few movements of the intracranial volume lever soon vanishing entirely (Figs 8 and 9); and (3) those in which brain flap was easily induced when desired.

The clinical observations may be divided into three exactly similar classes. The absence of references in surgical literature to phenomena of this kind can mean only one of two things—either brain flap is so common as to be unworthy of remark or so rare that it has been observed only on a few occasions. Considering the frequency of trephining as an operation and the rarity with which this condition has occurred in our experience it is clear that the second explanation is correct. Stertorous breathing is frequently associated with the conditions for which trephining is performed and yet brain flap is practically unknown. Therefore the ordinary trephine operation in a case in which there is some obstruction to breathing forms an exact parallel to our first class of experimental findings.

I have to thank Mr. J. H. L. for his help in the preparation of this paper.

Reference to the first section of this paper will show that in our fourth and fifth cases there was a transient appearance of brain flap. The movements were associated with deep respirations but soon disappeared. The two cases may be considered as similar to or even identical with our second class of experimental findings.

Our first and third clinical cases and probably Wheeler's case should be joined to them—displayed movements of the brain associated with difficulty of breathing which continued for some time. They are sufficiently parallel to our third class of experimental findings to permit us to suggest that there must have been similar causes at work in the two conditions. Only one important objection seems possible that in the clinical cases the condition arose apparently spontaneously but in the experimental work only with active interference. This objection we think is not well founded. It is true that in our later experimental work care was taken to block the tracheal cannula completely. This was done to give us a firm basis for our work. In the earlier experiments, it was observed that brain flap could be produced by far less vigorous interference with the air entry such as might occur with excessive mucus in the trachea though the movements were then less pronounced. It is of course impossible to say how much or how little resistance there was to breathing in our clinical cases and consequently how much change in the intrathoracic pressure would occur on inspiration. We feel that with the closely parallel results that have occurred in the operating theater and the experimental laboratory we are justified in claiming that we have reproduced in dogs a condition exactly similar to the rare occurrences of brain flap observed clinically.

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9. *Hitherto* it has been thought that brain flap seems not dependent on interferences with

10. The minute changes in brain flap would appear to be a function between the quantity of blood removed leaving the cranial cavity and the minute amount

11. It is certain that the principal factor in the production of the excessive expiration is the chest during hyperventilation. It is probable (a) that a relatively constant inflow to the cranial cavity from the ventral side may be an essential factor and that while a high pressure of the pleural fluid will damp the movement of the brain a fall in pressure may permit them to appear.

Much valuable attention in this subject is given by Dr K. Samaan, M.Sc., Ph.D., a letter of which to acknowledge the interest in the heart as that which prompted the

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CLINICAL SURGERY

FROM THE ORTHOPEDIC SURGICAL DEPARTMENT OF THE MASSACHUSETTS GENERAL HOSPITAL

FUSION OF THE SPINAL COLUMN

BY NATHANIEL MILFORD M.D. F.A.C.S. BOSTON

A operation the purpose of which is to create a bony union between several vertebrae is indicated when either injury or disease has caused or is causing a destruction of one or more vertebral bodies. It is also indicated when the spinal column is curving laterally as a result of paralysis of the muscles or congenital defects in the bones.

The indications which present the chief indication for spinal fusion are tuberculous of the adult spine, compression fracture of the spine, scoliosis which results from poliomyelitis and scoliosis due to congenital bone defects.

DANGERS AND POSSIBLE COMPLICATIONS

The greatest demand is the rough exposure of the posterior spinal arch through out an extensive area.

The chief danger is that of surgical shock or operative infection. Infection is a most serious complication, danger again to which every precaution in the very careful operative technique and in the use of technique is to be taken by the surgeon. There is little danger of serious hemorrhage and little danger of damage to vital structures prior to the operation; carefully done.

PREPARATION OF THE PATIENT

The patient should be given rest in recumbency for several days before operation is undertaken. During this period he should receive the maximum rest and free sleep with light diet and free air. The bed should be firm and unyielding and only one pillow should be used.

The feet should be the entire back and the thighs up to one of the leg. The back should be well rubbed with soap and water and then with ether and alcohol the day before

operation. The leg should be prepared in the same way.

The choice of anesthesia rests with the surgeon. Ethylene or ether seem to us to be best suited for this operation.

The patient is placed face down on the operating table. To secure comfortable breathing in this position and to lessen surgical shock, the use of the cerebellar table is recommended (Fig. 1).

The back and one leg are exposed and painted with iodine. The leg is flexed at the knee so that the heel rests near the buttock of the same side (Fig. 2). This exposes the anterior tibial surface. The table and leg are draped with sterile sheets. It is quicker and there is less consequent shock if the two operative procedure are carried on simultaneously (Fig. 3). The operator and his assistant prepare the spine for fusion while the second operator and his assistant remove the graft from the tibia.

STEPS OF THE OPERATION

1. An incision is made in the midline over the tip of the spinous processes. The area of the spine to be fused has been determined by previous study of roentgenograms. Two vertebrae on each side of the vertebrae principally involved should be included. This means that provided the tenth and eleventh dorsal are chiefly involved then the fusion should include the eighth and ninth above and the eleventh dorsal and first lumbar below. The incision therefore should expose the spinous processes of the eighth dorsal to second lumbar vertebra inclusive.

After the division of the skin by vertical incision directly over the tips of the spinous processes the posterior spinal ligament is exposed. The tip of the spinous processes are clearly seen and felt. The ligament should be divided accurately in true vertical line in the middle of each spinous process. This is best done by securing each spinous process in the grasp of a curved clamp and making a vertical knife-cut in the

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11. Fig. 12. Fig. 13. Fig. 14. Fig. 15. Fig. 16. Fig. 17. Fig. 18. Fig. 19. Fig. 20. Fig. 21. Fig. 22. Fig. 23. Fig. 24. Fig. 25. Fig. 26. Fig. 27. Fig. 28. Fig. 29. Fig. 30. Fig. 31. Fig. 32. Fig. 33. Fig. 34. Fig. 35. Fig. 36. Fig. 37. Fig. 38. Fig. 39. Fig. 40. Fig. 41. Fig. 42. Fig. 43. Fig. 44. Fig. 45. Fig. 46. Fig. 47. Fig. 48. Fig. 49. Fig. 50. Fig. 51. Fig. 52. Fig. 53. Fig. 54. Fig. 55. Fig. 56. Fig. 57. Fig. 58. Fig. 59. Fig. 60. Fig. 61. Fig. 62. Fig. 63. Fig. 64. Fig. 65. Fig. 66. Fig. 67. Fig. 68. Fig. 69. Fig. 70. Fig. 71. Fig. 72. Fig. 73. Fig. 74. Fig. 75. Fig. 76. Fig. 77. Fig. 78. Fig. 79. Fig. 80. Fig. 81. Fig. 82. Fig. 83. Fig. 84. Fig. 85. Fig. 86. Fig. 87. Fig. 88. Fig. 89. Fig. 90. Fig. 91. Fig. 92. Fig. 93. Fig. 94. Fig. 95. Fig. 96. Fig. 97. Fig. 98. Fig. 99. Fig. 100.



Fig. 1 The cereal table which consists of a horizontal bar and two shoulder supports. If the patient is tilted downward on the table as is necessary in the final operation, spinal shock is increased by the fact that the forceful movement on the spine itself is transmitted to the patient's abdomen. By the use of the shoulder supports and the headrest the weight of the operation is transferred to the shoulders thus protecting the abdomen and head. Another valuable feature of this table is that it tilts the spine in a straight position.

mid sagittal plane of the spinous process (Fig. 4). From this entrance point the muscles, fascia, and periosteum may be stripped from the side of the process and along the lamina below. The splits in the processes are united by a longitudinal incision throughout the region to be exposed (Fig. 4 A).

By blunt dissection with a periosteal elevator (Fig. 5 A) and by gauze picking (Fig. 5 B) the entire posterior arch of the spine is then exposed. Retraction is accomplished by deep retractors and later when the posterior arch of the spine is exposed by self retaining retractors (Fig. 5 B).

3. *Preparation of bony bed* From the surface of each lamina down as far as the lateral articulation a bone shaving is turned up with a curved chisel. The lateral articulation is entered with the chisel and small curette and the articular cartilage of the articulation removed. Each spinous process is split longitudinally into 3 fragments with a chisel and the spinous process is cut across at its base so that these fragments may be broken down to lie in position overlapping the space between the spinous process above and the spinous process below thus bridging the entire area of the posterior spinal arch with bone fragments each of which is still loosely attached to a base. All of these fragments are flattened out so that the surface is a rough surface for fractured bone fragments continuous from the upper limit to the lower limit of the area to be fused. On each side of the midline a osteoperiosteal graft from the tibia is now placed bone side down. Two strips of osteoperiosteal material $\frac{1}{2}$ inch wide and long enough to reach the limits of the denuded area.

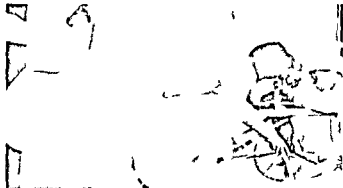


Fig. 2 The patient is tilted on the table as is necessary in the final operation. The patient is tilted on the table as is necessary in the final operation. The patient is tilted on the table as is necessary in the final operation.

The incision is checked and controlled by tight packing with gauze strips being used.

4. *Suture* The ligaments of the supraspinous ligament are sutured together over the entire area with interrupted sutures of 30 day chromic catgut No. 1 or with silk sutures. The skin wound is closed with interrupted sutures of silk.

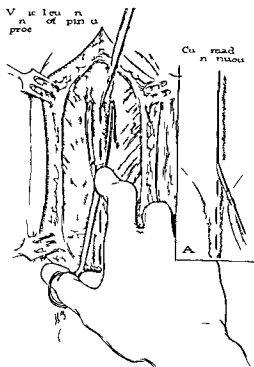
REMOVAL OF THE OSTEOPTERIOSTEAL GRAFT

While one operator is preparing the bony bed on the posterior side of the spine the second operator removes the osteoperiosteal graft. He has as a rule time to do this in a leisurely manner as it takes longer to prepare the fusion bed. He should not anticipate the preparation of the spine because it is a valuable piece of technique to transfer the graft immediately to its future bed without delay and unnecessary handling. The graft should be cut free at the moment the spinal bed is ready and at that time transferred.

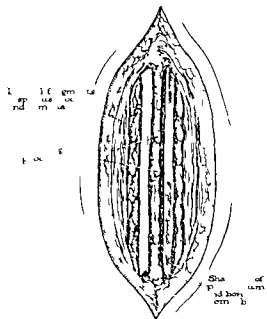
1. Incision is made from the tibial tubercle to a point 4 inches above the internal malleolus the



Fig. 3 One operator has the spine as his field of operation. A second operator is preparing to remove the tibial graft. The leg is held steady by the use of a sterile bandage which is placed around the end of the table.



l 4 Mt tl l f th p p th ll
ll l m tl l l l th p p
th f mpl l l mp tl t t tl p



l 4 Mt th l l h b l l t d
l d d th po t h t f med to a de
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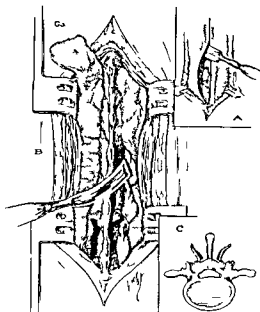


Fig 5 A I t d m l puh lf mlt l
uf f p p s ll m e B l C Sp
p pl t t tl f a m t t t lf m t t
pl d t d l l l m ll f km t f
t l t l d d pl l l th d a d

entire subcutaneous surface of the tibia exposed. It is well to mark out the graft with 2 longitudinal incisions made with a knife through the periosteum well into the cortical bone. The graft should be 1 inch wide and should be long enough to reach over the entire spinal area; i.e. it should be as a rule about 6 to 8 inches in length—this may be definitely decided by the use of a measuring probe supplied by the operator at work on the spine.

A sharp chisel the width of which is exactly that of the marked out graft is started at the upper end with a mallet this chisel engaged in the bony surface of the tibia and by repeated light tapping the mallet a shaving is rolled up (Fig 7 and 8). It is important not to cut out with the chisel but to keep the edges of the instrument engaged in the subperiosteal bone. As a result the shaving removed should have periosteum on its upper surface and its under surface should be made up of a layer of subperiosteal bone (1/3 in. in thickness). This strip 1 inch wide is then cut longitudinally making strips 1/2 inch wide and these should be transferred to the first perforator for implantation in the bony bed.

The wound over the tibia is sutured with interrupted silk stitches and a tight compressive bandage applied.



FIG. 7 (left) The removal of the soft tissue from the subcutaneous surface of the tibia is exposed. The chisel is started at the lower end through the periosteum into the subperiosteal bone.

FIG. 8 The removal of the osteoperiosteal material is continued from the anterior surface of the tibia by shaving, of osteoperiosteal material is continued from the anterior surface of the tibia. This is divided into two pieces which are transferred to the spinal field for implantation.

POSTOPERATIVE CARE

As soon as the operation is over—it should be done in about 1 hour or less—an estimate of the patient's general condition should be made. pulse rate and blood pressure compared to pulse rate and blood pressure before. The anesthetic chart is very important because the operation has peculiar possibilities of creating surgical shock. In all instances whether or not shock is evidenced the patient should have shock treatment. He should be returned to bed as soon as possible. Heat elevation of foot of bed, shock enema, forced fluids, subdermal fluid if necessary, and morphine in sufficient quantity should be employed. If at the end of several hours there is evidence of postoperative shock, blood transfusion is indicated and 500 cubic centimeters of suitable blood should be given. The blood donor should be available during the first 24 hours after spinal

fusion is performed. We have not found it necessary to place these patients on frames or in apparatus such as braces or plaster of Paris shells. A firm mattress is all that is necessary for the first 10 days. The use of pillows should be avoided.

After the removal of the sutures and when wound healing is established the patient should be supplied with a suitable brace or a plaster of Paris shell.

Absolute recumbency is necessary for a period of from 8 to 12 weeks. The patient should not be allowed up until a suitable jacket of plaster, leather or celluloid or a proper metal brace has been adjusted. The period of being up and about is gradually increased from $\frac{1}{2}$ hour to full activity. Support and protection of the spine as well as carefully planned supervision of activity is necessary for at least 1 year after the operation.

FROM THE GYNECOLOGICAL CLINIC OF THE UNIVERSITY OF GHEENT

INTRA-ABDOMINAL INCISION OF THE VAGINAL VAULT FOR DRAINAGE

BY DR. C. BATTIN (CHIRURGUS)

A. T. F. B. L. C. D. p. m. f. b. G. e. l. k. l. C. f. h. U. y. f. h.

Our modern aseptic and antiseptic methods have made the use of extensive drainage less common than formerly. Even in a severely infected case it is advantageous to close the abdomen completely, although if hemorrhage persists or the wound surface is sloughed and necrotic tissue remains one will not hesitate to make use of extensive drainage.

Extensive drainage is to be recommended chiefly after ablation of the appendix in the presence of many adhesions after operations for carcinoma of the cervix for hæmatocele or for adherent necrotic tumors. When it is only a matter of arresting a hemorrhage pressure can be produced with a tampon and the drain can be brought out side along the lower part of the abdominal incision so that it may be removed after 24 to 36 hours. In such case we always inject paraffin oil mixed with 10 per cent oil of camphor.

However when the wound surface is large or considerable necrotic tissue remains it is essential to use more extensive tamponage and drainage through the pouch of Douglas and the vagina. In this procedure several mistakes are commonly made. In an attempt to secure drainage of the pelvis through the pouch of Douglas it is not easy to open the vagina with curved scissors and often the tissue are irregularly cut and ruined.

After supravaginal hysterectomy it is difficult to open the posterior vaginal arch. When a long

curved forceps has been introduced into the vagina it is necessary for the operator to guide an assistant's hand in the protruding of the posterior vaginal arch by means of the instrument. After cutting through the posterior vaginal arch we sometimes have to cope with hemorrhages from the vaginal wound. Therefore it is wise to place a suture at the right and left sides on the edges of the vaginal incision although it may be difficult to do this because the edges of the vaginal incision lie deep in the pelvis.

In order to avoid some of the usual difficulties we have made use of an instrument which consists of two movable arms held together by means of a set screw. The curved arm carries a sphere which is introduced into the vagina as far as the posterior vaginal arch shortly before the operation after the abdominal wall and vulva have been disinfected (Figs. 1 and 2).

During the operation the surgeon can move the handle of this instrument so as to make the posterior vaginal arch protrude into the abdominal cavity and extend upward so that it can be reached quite easily (Fig. 3). On the sphere there is a longitudinal and a transverse furrow. The former facilitates the incision in a forward or backward direction; the latter serves to pull the thread on the right or left side through the edge of the vaginal incision so that it cannot glide off the smooth surface of the sphere. The transverse

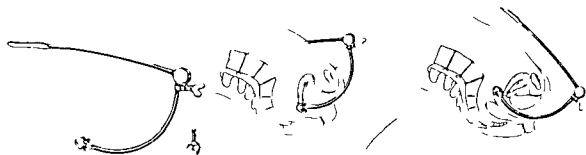


Fig. 1. Diagram of the instrument. Fig. 2. Diagram of the instrument being used to reach the posterior vaginal arch. Fig. 3. Diagram of the instrument being used to pull the thread through the vaginal incision.

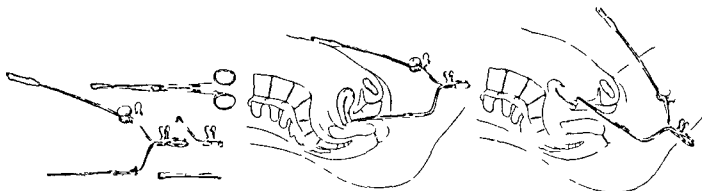


Fig 4 Another attachment and forceps

Fig 5 Application of instrument

Fig 6 Instrument in use

furrow is also useful when a transverse incision is used in a total hysterectomy. In the foremost part of the longitudinal furrow there is a little bridge around which can be turned the end of a drain or to which a thread may be attached that will carry the drain into the vagina when the instrument is withdrawn.

A similar attachment but provided with a crow bill and different forceps which can be hooked on to a portion of the vagina is also very useful (Fig 4).

Figure 5 illustrates the manner in which the forceps is fixed and the other part of the instrument is screwed upon the handle of the forceps so that at any given moment the operator may seize the handle of the instrument and at once bring to

his hand in the abdominal cavity a well defined part of the vaginal wall (Fig 6).

The MUSEUX forceps has the advantage that when pressure is exerted on the instrument the forceps will not pierce the tissues. In ovarian implantation the instrument can be used to draw an ovary into the uterus by means of a thread.

The seizing of certain parts of the vaginal wall chiefly the foremost vaginal arch and the possibility after laparotomy of recognizing distinctly this part of the vagina and of pushing it upward is extremely advantageous in Wertheim operations for carcinoma of the cervix and even in cesarean operations when a drain is to be placed in front of the incision in the uterus and led downward along the vagina.

modified Sturmdorf technique. The tubes were thickened and somewhat reddened but fimbriated ends were not closed. Milking of the tubes failed to express any discharge. As the patient wished to avoid sterilization the tubes were not removed. A retroversion was corrected by suturing the round ligaments behind the uterus. The highest temperature after the operation was 100 degrees and the highest pulse was 96 but neither became quite normal and the patient felt depressed and ill. On the tenth day 3 pints of pus were evacuated from the lower angle of the wound without benefit. On the nineteenth day the patient began to complain of rectal tenesmus. A munction disclosed a small collection in the pouch of Douglas. Under ether the posterior fornix was incised about 3 drams of pus was evacuated and a split rubber tube inserted. Rapid recovery followed. The patient was seen again on September 9, 1916 that is nearly 5 years after the operation. She had been fairly well except for nervousness which was attributed to excessive menses. There had been no dysmenorrhea or abnormal discharge since operation. Examination showed a normal cervix. The appendages were slightly enlarged and slightly tender. The patient had been living with the same lover ever since but a condom was always used in coitus.

This case demonstrates how treacherous a gonorrhoeal infection always is and what a risk is taken when an attempt is made to preserve the tubes under such circumstances. It is probable that she would not conceive even if the use of condoms were discontinued. A total hysterectomy would have left her in better health provided the ovaries were not removed.

CASE 2 Mrs G B 34 years of age nullipara consulted me on January 9, 1924 for pain in the lower abdomen, rectal tenesmus and dysuria which had troubled her for 2 days. There had been 3 similar attacks preceding the last 3 periods. Temperature was 101.4 degrees, pulse 100. A vaginal and rectal examination disclosed a myomatous uterus and a tender fixed mass in Douglas's pouch. The diagnosis was inflammation or suppurating ovarian cyst complicating myoma.

On January 11 under ether posterior vaginal caeliotomy was done and the supposed cyst was carefully separated. The abdomen was then opened and subtotal hysterectomy was performed, both appendages which were normal being left. The supposed cyst proved to be an enlargement of the pelvic colon, hard and nodular, resembling a malignant growth. The bowel was divided well above and below the growth and after thorough removal of the latter with the surrounding tissue the bowel ends were reunited by the Rutherford Morrison method—passing a large tube down through the anus, suturing the upper end inside the proximal bowel making traction on the lower end and in a minute the upper end of the bowel into the lower then suturing with fine chromic gut. A small rubber and gauze drain was passed into the vagina through the vaginal caeliotomy wound.

The bowels moved by castor oil in 50 hours. The bowel tube and drain were removed on the eleventh day. Temperature and pulse continued as before the operation. On the eleventh day a small quantity of pus was evacuated from the lower angle of the abdominal wound and the temperature dropped. On the seventeenth day a rigor took place and the temperature rose to 101.4 degrees, pulse 104. Micturition was frequent and painful and the urine showed a trace of pus. Vaginal examination disclosed a slightly tender exudate in the anterior fornix.

Under ether the bladder was dissected up and the finery pushed into a collection of pus in the uterovesical pouch. A split rubber tube was inserted here and another in the old opening in the posterior fornix dilated for the purpose. After this there was an immediate improvement in all the symptoms. The rubber tubes were removed on the fourth day and the patient left the hospital 6 weeks after the original operation feeling very well.

Professor Welch reported the specimen to be one of diverticulitis. One of the most remarkable I have ever seen, there are only two diverticula—one extends beneath the peritoneum and on the point of perforation the other has also penetrated beyond the muscular coat into the mesentery. Here a small necrotic abscess has developed.

When as in this case it is not possible to lift the bowel out of the pelvis so that it can be sequestered prior to resection it is difficult to guard against infection and suppuration. On March 31, 1925, 5 months after operation the patient reports as having had no trouble since. A satisfactory follow up had ascertained this.

POSTOPERATIVE INTESTINAL OBSTRUCTION

Vigilant watch should be kept for the dangerous complication of postoperative intestinal obstruction. Promptness is the very essence of its successful treatment. If vomiting associated with paroxysmal pain occurs in a patient who has been doing well for a week or so and if two large enemata fail to bring away flatus and feces with relief from the symptoms within 12 hours a diagnosis of intestinal obstruction should be assumed and appropriate measures taken without delay. In the following case and another exactly similar to it I adopted a method of treatment which is not mentioned in any of the well known textbooks and which in these cases was attended by success. The method is worth bearing in mind but should be used with discrimination. The surgeon must be in a position to exclude definitely peritonitis or suppuration.

CASE 1 Mrs Z age 44 years was admitted to the Lister Hospital January 1923 suffering from hemorrhage due to myomata. An operation had been performed by another surgeon several years previously for retroversion and salpingitis. I did a total hysterectomy leaving both ovaries (the tubes had been removed at the previous operation). Moderate adhesions were present. The patient convalesced easily until the sixth evening when she was seized with paroxysmal pain and omitted several times two large turpentine enemata during the night failed to move the bowels or bring away flatus. When I saw her the next morning she looked anxious but not very ill. Pulse was 100, temperature 99.6 degrees. The abdomen was moderately distended but not tender. Vaginal and rectal examinations disclosed nothing abnormal.

While preparations were being made for the reopening of the abdomen I thought I would try succussion. Standing on the bed at the foot I seized the patient's legs beneath the knees and lifting up her body so that she rested on the back of her neck and added by the spring mattress I gave her three fairly vigorous shakes. Another large turpentine and soapy water enema was then administered. This acted promptly and brought away fecal matter and much flatus. The subsequent convalescence was uneventful.

Ca L l s y r s o f a p a h d s f d f m t b s e d e n t T h e p p e d a i n t h e l o c k
 h a m h f o y a O n O t h 26 9 6 a t o t a l p u t n d a n o t m o d A l a r g m t o f g r a l
 l y e c t m y v a p r f r m e d T h p t a s d f f l t o t y a f o d n t h e u t i c t y h h t h
 l y u o t h o b y o f t h e p a t a d t h e d p t h o f t h p a t h o l r e p o r t d a n m l n n t
 p l T h p t o a l e d l l t h t h i e t h C o a l e s c e s v u t l t h g h t h d y h t h
 d h n h n t d a l t m s l h b o l m d p t t o m p l a d o f p a i t h l e r b d m l
 t h t d y l t t o m i n t n d I d d o t s t h o m t d t c T m t a f l d t m t h b l
 i t n t l t h f l l o g d a y S h t h m b d T h e l a b d o m d d t d d s l h t l y d
 l d d y h o r s i t l o s t m t m t h d T h m e g d t h t h l o e p t f i t h l
 t h l m g t h d t e d d a d h t t o t h e r o e o p e d b u t h t h f e p u h d d o n l y
 l n l t h l f t a b u t 8 h f m t h c e c u m l t l b l o o d u i d A p l t r u b b e r d
 l h l m g o m l t h d h t p t h d d g e p d i t t h a a t h r u g h t h s h l o f t h c e r v A
 l t t h t h b r u t T h d h b e l g n d o s a a t h m d e n t h g h t l g o
 l y p t d l t t h p o t f t h p o t d t n d d l o f l m p e s e t e d T h s w g o l
 t m C e t d m n I d d t a s p t y t h t t h g h p r s t n t a d g e t b t e d
 t t h W d t h d l o c t f t h t c e t h b l d s t e d a t h t c o f f c t g t
 t l h p l t p t t k l l t h o t r T h f t p t t e a s t h t u e d t h t l y c l g
 t t h d y h t h m t a t d l g t t h t r u b b e r t b A t h p t i g s p e d n i t d
 a t h l a t h I d d o g t h p o o m n t h a n t h m e y T h b o l a s t s t u d t t p t
 h f a n t t m p f m d l l a t h a c l b u t t h b e y T h d t o t h e k t p t a c l
 C 3 S t l t f t h e l u m b y m t a l b d t a l p l l u t T h d t l d f t h t b a c l d
 t l r v f t d f t h b l n d l f t f t h t b b y f d g b o t t l h h t d t t h p t d
 l l l l t f t h p l A h t n c y t l f l L a g q d t o f r y f l d k f l d p d a l
 l t t t r p t f t h I h p t p g c y d h h t h f l l c k d t h b o l s i t d t h g h
 l l t l l a d i f l e s h t h t b t l o m l e V m t d t o c t h
 3 O M l o q I d d l n p d b l m o d u t a m i 48 h o u s T h e t b e a
 t t h l a l s p l t h p d O m t h m l t e s p a t l l y l d s d y l t T h t e m p t k y p t
 t l m l d h I e c t h p l d t h o o d g d d t h p l a t t o o f 8 l y s
 l l t t d O t h t t h d y b o t h r e a t t o o h n s l h t
 h l l t t l l l l t l t h l y l l f t m p h l b i h e d t l f T h i t t d
 h l r l y l l t b m d t h t h d y t t h h a g d l l 48 d y f t t h s t o p t T h p a t t
 t d t l l t t n f t h m a t N f l t f e g o o f b r u r y s 9 6 d f d t b
 u l d l h t T h t p r t f m n m l f f y s n s t l B m n l m t n d
 t p o d g a d t h p l t 4 T h d m e l d t h g a b l
 f l f l t t l t h t h d y h n l l t d t t C e s I t t a l b t t n t e t d f t b y m l p l
 p p d l h g t t s a d h l d f t h d g n n d t d y f t d b y t t m y M
 t t p t h t t p p d l h b d m a k d x m O p t o d c l o d o d t l
 t b d f t h t t t h l m d m t l d h t m t m b a t h t T h l f t a r y h h
 t t t l t b h t D a l p h O s a c y t t t r y b l o o d y c o t t d s d h t
 p t d l f t p t h t t f d t h t t h p l l m d f h t r u m h
 l u m l h b f d t l t l b l t l l l g d d d l t h m y m t t e c s o l
 t l t d b t h e m t l t T h b l d l t d m k d c y t d h t t t l t h y t r t m y
 l l p d t l t h l t f t t T h d A d t c l m f m t h c e h h a d h t
 b l t t t l y m d F h m t m s t t h h t f l l o p t b m d a d t h p m l
 n d d t h t m d d a s b d T h p p n d l d t
 l l p t p d d t i m m d t l b g t d m o d
 t l l h l t l l b n g d t d T h T h p t n t l d f a l y l l t h p l
 l l m f t h t m b m p d q c k b t k T h O m t d d t t
 l l h d l y f t t h p t 96 t h t f t h f i r s t d a y s b t t a e l e d b y m t T h
 u 6 N f t h t t o o k p l C l p t t p o e s s d f a b l y t l t h h t f i t y h
 b l d d b t h d l d p f c t l y d h o m t g t d n d b e c m f l T h
 C 4 l t e s t l b r u t u e s f l l y t r d b t m p t m d o r m l a d t h p l h 6
 t t m y M r s I B 44 r s f m e d A t l o c k t h t m o t o d l y h l e d
 J p o l l 4 r p m l y h h d h d p e r p l p n d d l g h t m o t f t r u d h d e p e l
 p f o l l t b H m h h d n t e d o a T h s m l t e s t e d t d e d n e d d n A l o o p
 d t h t b h a d b l t e d t p t f t h r d h t D u g l p h a m k e d l y k d a t
 p a s s M s t u e d t b e y e s T h p t l y c l l p d b e y d h k k m 16 y e s f m t h
 p a t t h d t k b d f k e s S h a s a m c a c m T h e d t d e d b o l e d s p l e s d
 j t t l l t b l k t h r y l l m l l d k f l d w a e v t d l f
 d l t d t h n h t p e d g s l g d a t a s l o s e d t h f h g t T h p f e w
 p r a t n J s k t d d d h e s n s o f t r p t o T h b o l m e d w l l t t
 m t m t t T h n h t r y h a d b e t r a t r p t m p e d e d t m s c u l j e t f
 f m e d t t T t l h s t e c t m y w t h m l f p t n O t h s e t h d y t h p l 4 T l b
 t h n h t c y s t s n e d o t N o s g a f l a t u d d m e n a s s t l l t l y d u e d N m t f t
 s p m t h p e c d d y O t h a f t m o o f t h b t h

day the vomiting returned distention increased and the pulse rose to 120 and was very weak. The patient's arms were quite cold and she seemed moribund when I saw her at 8 p.m. Ether was given and an incision was made in the right iliac region. A distended loop of ileum close to the cecum was pulled out and a rubber tube was inserted into its lumen by the technique described in a previous case. The patient was quickly returned to bed no worse than before the short operation.

On the next day the ninth the patient was distinctly better. Much flatus and liquid foul smelling feces were evacuated through the tube. Vomiting ceased. On the tenth day the bowels were loose the pulse was 104 the patient was in good condition but felt lo. On April 16 the fourteenth day after the first operation and the sixteenth day after the insertion of the tube into the bowel the tube was removed. The median wound was suppurating the patient looked dull and poisoned pulse was only 100 and the temperature was normal. After this progress was steady and on May 29 63 days after the first operation the patient was discharged feeling well. The right iliac wound had suppurated and was not quite healed. A thin probe could be passed into the bowel. Six weeks later the patient reported wound healed and felt well. On July 1922 2 years later the patient consulted me for an attack of epistaxis. She was otherwise very well. There was a slight hernia in the lower end of the median scar. The pulse felt normal except for the absence of the uterus. I think it would have been better at the second operation to have done an enterostomy and have left in a tube instead of attempting to empty the bowel by puncturing and suturing the openings.

In the foregoing histories the symptomatology of postoperative intestinal obstruction is well exhibited. The patient does well for a few days or weeks and then suddenly vomits and complains of paroxysmal pains. Flatus ceases to pass and the bowels cannot be properly moved. The temperature and pulse remain unaffected for a time. There is increasing abdominal distention but no great amount of tenderness.

The patient's life depends upon unhesitating action. If two enemata fail to bring relief succussion as described should be tried. If this is unsuccessful the abdomen should be opened the hand passed into the pelvis and all small intestines lifted up and inspected. If the contents of the distended bowel can be easily milked into the collapsed bowel probably all will be well if not an enterostomy should be done. Puncturing of the distended bowel in several places involves too great a risk of infection. I have not tried Handley's ileocolostomy with cecostomy or Bonney's jejunostomy. The passing of the enterostomy tube through the omentum as advised by Dr Wesley Long is a device worth bearing in mind.

I am inclined to think that many cases of paralytic ileus with peritonitis may own a mechanical basis or be associated with a mechanical obstruction and that a timely enterostomy might have saved some of my much regretted fatalities. It is now generally recognized that in death from

peritonitis the patient is poisoned by absorption of the toxins formed in the stagnant intestinal content. This suggests enterostomy as the most hopeful treatment.

ACUTE DILATATION OF THE STOMACH

CASE 1 Mrs J M 60 years old was examined on October 16 1919 and complained of attacks of gastritis accompanied by vomiting for 3 years. Morphine had been necessary to relieve the pain. Vomiting did not relieve the pain but food seemed to determine an attack. The patient had lost flesh and felt weak. X-ray examination reported gall stones with gall bladder adherent to transverse colon and pylorus or ulcer of the pyloroduodenal segment.

On October 22 1919 cholecystectomy was performed and 14 small sharp edged gall stones were removed. A tube was sutured into the gall bladder without attaching it to the parietics. Neighboring organs were normal except for the liver which appeared nutmeg. The patient collapsed well. The tube came away on the tenth day. There was a free flow of bile from the sinus. The stools showed no mal bile appearance. On the thirteenth day the patient suddenly began to vomit large quantities of coffee at first later the fluid seemed to simply overflow from the mouth. There was no pain no tenderness and no pyrexia. The urine contained no bile. The bowels moved easily by enemata. Distention was present in the upper abdomen but not in the lower. The pulse was 100 to 112. Bile flowed freely from the sinus.

The patient as placed in the prone position the foot of the bed was raised 18 inches. Pituitrin strychnine and digitalis were administered intramuscularly and the stomach was ashed out several times daily. The vomiting gradually abated but continued more or less for 10 days and recurred occasionally for another 14 days. The patient was quite well 6 weeks from the day of operation.

CASE 2 Mrs A A 44 years old complained of nasty discharges profuse menses and gastric pain. Pathological examination showed a very large sessile polypoid stending from the vagina. Several myomata were felt in the hypogastrium. On June 17 1924 the polyp was cut away by morcellation. Abdominal section was made and total hysterectomy performed. There was considerable subserous development. The bladder was drawn up over the face of the tumor. That afternoon the pulse was 84 and the temperature 99.2 degrees. Partial incontinence of urine lasted for 48 hours after operation.

On June 20 the patient was still vomiting but the bowels acted well after enema. The pulse was 84 and the temperature 99 degrees. Lavage of the stomach gave relief for 12 hours then vomiting resumed. Lavage was repeated and again the vomiting ceased. On June the patient enjoyed a breakfast of eggs and toast but at 2:00 p.m. there was a sudden attack of epigastric pain and vomiting followed by collapse. The pulse ran up to 160 and as thready. The stomach tube evacuated over 4 pints of darkish fluid and immediate improvement followed. I think by hypodermics of eserine strychnine and digitaline the raising of the foot of the bed 8 inches the keeping of the patient in a prone position and the administration of rectal saline every 4 hours. The vomiting ceased after this. The stomach tube found no fluid in the stomach. Next day the pulse was 118 and had good volume. No further vomiting occurred until the tenth day when it returned and was again controlled by lavage. It returned again on the thirteenth day and the tube evacuated over a quart of dark fluid with explosion of gas.

Th a n fu th om t g aft tl s Th s pp rt ng
 lk rm gut t s e r m ed th ht nth d y
 Ih p t nt pp tly mal ry y a d the
 O t l f th l t t l l th l t t f l t
 a d t l t t f d l at t t d s b d
 a d m t s d t o t m th l t nt
 f h l l th t g n a sth t (sra f
 m rph a had p e ly b g) I hed th tes
 t s t l l l t pl d th m bo pht th
 m t m d a d es t ed the nd as th l t
 ta e p t el t fpl gut thr b d
 th sh to th pe t n m of lk m gut t r
 p ros bc t o t a d k pl gut
 Ih p t t em d s f e t d by th nto a d oc
 Th upp t s tu s e m d d ys
 d th j a dly h al d th t a d at
 th t th d l st p Th a d t pp a d t h b e
 a d b / th m f 3 d y nd the g at d b l y
 th l d d

It is to be noted that in one case the symptoms of dilatation commenced on the thirteenth day and in the other on the fourth day. The diagnosis is not difficult the bowels are unaffected

while the sudden onset epigastric pain collapse and effortless vomiting of large quantities form an unmistakable clinical picture. The only effectual treatment is as described in the case histories.

In considering postoperative complications prophylaxis must not be forgotten. Perfect hemostasis careful operating the use of quick methods and not quick movements and asepsis will minimize the occurrence of these untoward events.

One word on a different aspect of the subject. In the treatment of all disease we are fighting a losing hazard. Sooner or later death will triumph and I will seize the Doctor too. In that hour the dominant note should be infinite compassion. This should prevail over all other considerations morphine must not be spared. In the words of Dr Robert Hutchinson "When our time comes let us hope we may fall into the hands of a doctor who knows the value of morphine."

THE SURGICAL IMPORTANCE OF X-RAY EXAMINATION OF THE OESOPHAGUS AND THE PHARYNX

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THE OESOPHAGUS

THE diagnosis of diseases of the oesophagus has progressed surprisingly since the dawn of the roentgen era. Up to that time the oesophagus could be examined only by means of sounds, a method which must be looked upon as not altogether harmless for the patient (aneurisms, diverticula) quite apart from its inconvenience and frequently faulty results. At about the time X-ray diagnosis appeared, medical diagnosis was also enriched by the addition of the method of oesophagoscopy, the importance of which is generally recognized in the surgery of foreign bodies of the oesophagus and extractions in general. This method has served us well in the search for important findings in pathological conditions of the oesophagus.

X-ray examination of the oesophagus is painless, harmless, convenient and very valuable. The method depends as is well known on the fact that the contrasting agent, the paste, is swallowed while the patient is standing upright and is held for a longer or shorter period of time at the level of the stenosis (we will consider stenoses almost exclusively in this paper). This affords us knowledge as to the upper level of the stricture. We can also make important conclusions as to the nature of the process on the basis of the type of the picture. The results obtained by a fluoroscopy in upright position (these can be completed by a plate) are nevertheless lacking in certain important diagnostic facts. Such an examination gives us a good view of the upper border of the process, but it does not inform us as to the extent of the condition in the oesophagus, since the contrasting mixture passes through the oesophagus in a regularly narrow line. In order to fill this great need in oesophagus diagnosis, our clinic pointed out (6 and 7) the importance of X-ray examination of the oesophagus in cases of stricture in horizontal position of the patient. The patient swallows the contrasting mixture after taking up a horizontal position. The transportation of the mixture through the incompletely stenosed oesophagus is a slow one in this horizontal position and the result is a complete filling of the oesophagus. In incomplete stenoses

this means not only a cast of the contours over the stricture, but also within and below the area of stenosis. Although this method of examination is of little value in tumors of the thoracic section of the oesophagus because of the dubious prognosis of operation in such cases, it is all the more important in cicatricial strictures. An X-ray examination of an incomplete cicatricial stricture of the oesophagus in this way gives us an idea as to the upper level of the stricture, its length and form. In short, we are no longer in the dark, but are now in a position to learn whether a stenosis is extensive or small, and this gives us a better foundation for the endoscopic treatment of the scar.

In examining the patient in a horizontal position, it is better to irradiate from a purely lateral position than from an oblique one, as we have previously mentioned (4) for the examination of the trachea following Littenfeld's suggestion for the lateral photography of the sternum.

The patient lies completely on one side (1) at an angle of 90 degrees to the table. The shoulders are drawn firmly back and the hands clasped firmly together. In this position with the humeral epiphyses directly over each other and the knees drawn up, the patient is fixed on his side. The head is supported by means of sandbags so that it is in normal position. The plates are 24 by 30 centimeters. The central ray falls on the midpoint of the distal clavicle and strikes the midpoint of the plate in the line of its projection (this is for the examination of the cervical section and the proximal portion of the thoracic section of the oesophagus). In order to examine the distal portion of the oesophagus, the plate and the tube must be displaced a suitable distance distally and the focus must be correspondingly lowered.

While lying in horizontal position the patient swallows a contrasting mixture of medium consistency. Before a plate is made the patient is examined on the trochoscope under fluoroscopy in horizontal side position. At this time one can observe how long it takes from the time the paste is swallowed until the oesophageal defect is completely filled. After the preliminary fluoroscopy, the plate is made with the Bucky Potter diaphragm while the patient is swallowing more of the contrasting mixture. The plate should be

taken at a moment after the swallowing act has begun the exact time having been judged during the swallowing at the preliminary examination (the interval between the beginning of swallowing and the snapping of the plate is between a quarter and a whole minute). It may appear more practical to some to combine the trochoscopic examination and the plate by snapping the latter during a satisfactory moment. This of course dispenses with the Bucky Potter diaphragm.

Figure 1 illustrates the value of X ray examination of oesophagus tumors in horizontal position. The lateral picture shows the location, size and topographical relationships of the tumor, the degree and the length of the stricture, as well as the shape of the oesophagus above and below the stenosis are also clearly depicted. We definitely see not only the upper but also the lower border of the stricture. It is often possible in the lateral projection as in this case to portray the tumor itself which stands out against the less dense lungs. Therefore this is definitely an oesophageal tumor which is localized in the proximal part of the thoracic section causing an incomplete stenosis of the tube. The stenosis begins somewhat below the level of the upper thoracic aperture and reaches down to about the level of the bifurcation. The thoracic section of the trachea is pushed forward and compressed from behind.

As we have already mentioned the information we obtain on the form of incomplete cicatricial strictures of the oesophagus by means of lateral irradiation is much more important than our results in the study of the tumors. Examination in upright position gives us information only on the upper level of the stenosis without orienting us on the lower portions of the oesophagus. In the event that the stenosis involves but a small portion of the tube it is important to know this. We must also ask ourselves whether the stenosis is extensive or not, what the shape of the stricture is and at what points passage is still possible. The questions must be definitely answered before any purposeful endoscopic treatment can be undertaken. The better we know the condition present the better will be our results in treatment.

The advantages of examining the patient in the horizontal position as against the upright position are illustrated in Figures 2 and 3. They demonstrate cicatricial stricture of the proximal portions of the oesophagus following hydroxide cautery. In Figure 2 (examination in upright position) the contrast mixture is seen to collect at a point above the bifurcation. Below this point there is a thread-like filling down to the cardia. The picture gives no information as to whether the whole

oesophagus down to the cardia is stenosed or whether only a small section of the tube is affected. Figure 3 (examination of the same patient in horizontal position) the contrast fluid swallowed in horizontal position shows that the stricture is only very short but the oesophagus widens normally 2 centimeters below this point. The stricture is due to a cicatricial shrinkage which has drawn the anterior wall of the oesophagus toward the back. A small passage corresponding to the posterior wall of the tube has been left. We are thus able to learn the length of the stricture, its form and the point at which a passage has been preserved (in this case along the posterior wall). Two centimeters below the upper level of the stenosis there is again a normal breadth to the lumen. The greater width of the oesophagus above the stricture is the result of a compensatory widening above the stenosis.

Figure 4 shows how well the X ray examination of the patient in horizontal position can reveal finer stenoses of the oesophagus (scar stricture following cauterization). Despite the unusual narrowness of the oesophagus in this case there is seen a complete filling of the tube not only above but also below the stricture so that we have a complete picture of the cicatricial shrinkage in the oesophagus. It is natural that only incomplete stenoses of the oesophagus are to be considered for examination in this way. For if the stenosis were complete its form could be definitely cleared up only by a simultaneous filling from above and in oesophagoscopy from below through a gastrotomy. Sometimes we can also get a general idea as to the length of a scarry stenosis by examining in horizontal position without filling the oesophagus. The lateral view of the cicatricial tissue discloses the latter to be denser than the air-filled lungs.

We must also mention the case of a congenital partial oesophageal stenosis. The patient was a 12-year-old boy who had always suffered from marked swallowing complaints. X ray examination with the patient in upright position (Fig. 5) showed the transient collection of the contrast mass in the oesophagus at about the height of the bifurcation. The oesophagus was rather markedly dilated above this point but from this level downward the oesophagus was seen only as a thin thread. Here again we were unable to decide whether the stricture reached as far as the cardia or not. Figure 6 was made with the patient in the horizontal position (the patient swallowed the paste in this position). It shows that the stenosis is 6 centimeters long and that below the stricture the oesophagus is again normally dilated (at 1). But this examination disclosed still another interesting point and

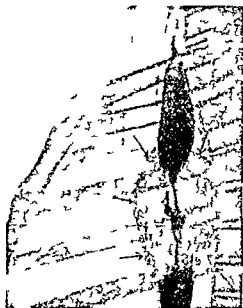


FIG. 1. Oesophageal tumor examined with the patient in horizontal position. The patient swallowed the paste in this position. The original photograph is at the right, the sketch at the left. One can see the upper and lower poles of the stricture and the form and extent of the stenosis. The tumor itself is clearly visible in this projection (marked by the arrow). The thoracic portion of the trachea is compressed from behind.

that is the presence of a second stenosis of the oesophagus somewhat below the height of the upper border of the sternum (at B). This stenosis was hardly visible in the examination in upright position.

X-ray examination of the oesophagus in horizontal position is not only valuable for the study of strictures but also in the diagnosis of pathological dilatations especially since bulgings of the oesophageal wall as Kloiber (2) has already mentioned fill themselves much better with the contrasting paste in horizontal position than in the upright one. The double Figure 7 illustrates these conditions and demonstrates a large *pressure diverticulum* at the height of the cricoid cartilage which as is visible in lateral view takes its origin at the posterior wall of the oesophagus in the cervical portion of the latter. The oesophagus has been pushed forward by the diverticulum and has also been quite badly compressed from behind.

The X-ray examination in horizontal position is however more important for the diagnosis of

traction diverticula than that of *pressure diverticula*. The former are not infrequently revealed only by this method of examination since a more complete filling of the oesophagus is attained in the method as a result of the slower passage of the contrasting paste (this was the reason why Palu³ (3) recommended the examination of patients with traction diverticula in raised pelvis position). We remember a few cases of middle aged persons with swallowing complaints in whom we suspected carcinoma of the oesophagus. X-ray examination in horizontal position showed that the cause of the stenosis was an acute angled bulging of the oesophageal wall a traction diverticulum. These traction diverticula can sometimes even lead to severe symptoms of stenosis as we were able to observe in a middle aged woman who also had a kyphoscoliosis resulting from a vertebral caries in the earliest years of life. The patient suffered from frequent and increasing complaints in swallowing which finally reduced her to a liquid diet. X-ray examination in upright posi-

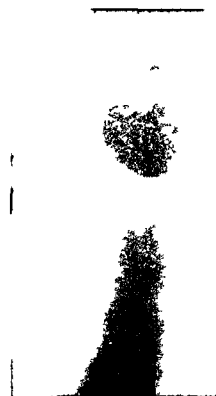


Figure 8. The filling in a normal mesopharynx. More than half the swallowed paste has already passed the epiglottis. The picture has a regular and highly defined contour. Orientation is further simplified by the laryngeal picture which is also visible in the plate. One can see the free portion of the epiglottis, its pedicle and its continuation into the ligamentum thyroepiglotticum from the lower border of which the vocal cord passes to the plainly visible arytenoid cartilage. The transverse breadth of the one sees the lower border of the cricoid cartilage, the tracheal aperture simultaneously the lower margin of the hypopharynx and its transition into the esophagus.



Figure 9. Illustrates a pathological case a tumor of the mesopharynx which protrudes into the hypopharynx and even farther into the cervical portion of the esophagus. As one can easily see the upper pole of the tumor lies just below the level of the hyoid bone. At this point a greater quantity of the contrast fluid has collected like a cupola over the upper pole of the tumor. The tumor affects the posterior and lateral portions of the mesopharynx and hypopharynx and has left but a small passage for the paste at the anterior wall of the pharynx. The picture also reveals the characteristically irregular and fringed border of tumors. The posterior wall of the pharynx is lifted from the spinal column because of a marked swelling of the former. This simultaneously seems to push the cervical part of the trachea forward. There is no transgression of the tumor to the spinal column—a point which is very important in respect of the operability of such cases. It is nevertheless impossible to operate in this case because of the great extent of the tumor especially since the neoplasm has already begun to affect the cervical portion of the esophagus. A normal filling of the esophagus is to be seen only

clear picture of the larynx and this is an aid in orientation. After the roscopy a careful plate is made so that the X-ray plate can be made separately with the fluoroscopic diaphragm a few seconds after the paste has been swallowed. In the latter case it may be necessary to take the plate several times in succession in order to catch the complete filling of the pharynx.

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Fig 8

Fig 8 Partial cast of a normal mesopharynx



Fig 9

Fig 9 Tumor of the mesopharynx which penetrates to the hypopharynx and also extends toward the cervical portion of the oesophagus. The upper pole of the tumor lies in the region just below the level of the hyoid bone.



Fig 10

Fig 10 Pharyngeal tumor. The upper pole is seen at the level of the arytenoid cartilage, the lower pole being at the level of the clearly visible calcified cricoid cartilage.

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Figure 10 illustrates a tumor of much smaller size. In this case the upper pole is easily recognized at the level of the arytenoid cartilages, the lower pole at the level of the clearly visible calcified plate of the cricoid cartilage. The tumor was removed by Hayek.

Figure 11 shows a tumor of the hypopharynx. The upper and lower poles of the tumor are easily recognizable, as are also the length and form of

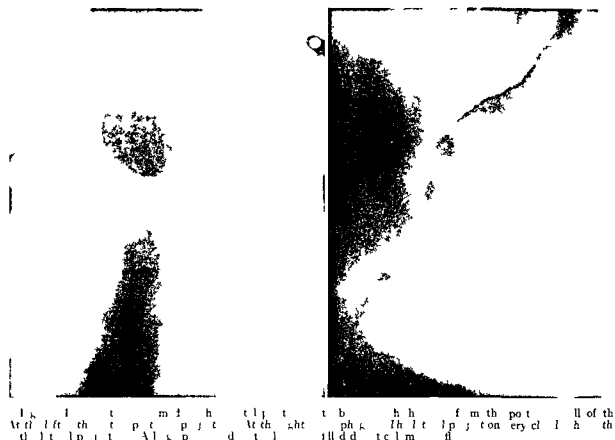
the stricture. The tumor is proliferating toward the larynx and forward toward the cervical portion of the trachea. It has already pushed the latter forward and compressed its posterior wall.

If the tumor is large, it is often difficult to get the upper and lower poles on the plate at the same time. In such cases we make one picture of the upper pole with a part of the stricture, and in a second picture we can then catch the lower pole with the stricture above it during a later phase of the act of swallowing. Such a double picture is shown in Figure 12. The picture on the left shows



Fig 12 A very long pharyngeal tumor. The picture at the left shows the upper pole with a part of the stricture. The picture on the right was taken at a little later phase of the swallowing act and shows the lower pole with the stricture above it. The upper pole is at the level of the epiglottis, the lower pole at the upper sternal margin.

Fig 11 Tumor of the hypopharynx. The upper and lower poles of the tumor are easily recognizable.



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The following illustration demonstrates that any roentgen examination can give a clear picture of the larynx. More than half the solid white paste has already passed into the larynx. The picture has a regular and fairly clear contour. Orientation is further amplified by the laryngeal picture which is a small white spot. One can see the free portion of the epiglottis and its continuation into the ligamentum thyroepiglotticum from the lower border of which the vocal cord passes to the glottis while arytenoid cartilage is shown realizable. One sees the lower border of the thyroid cartilage the tracheal aperture simultaneously the lower margin of the pharynx and its transition into the esophagus.

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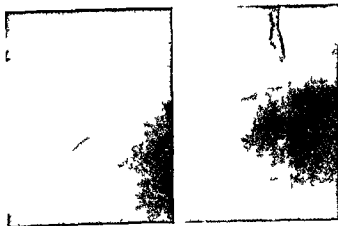


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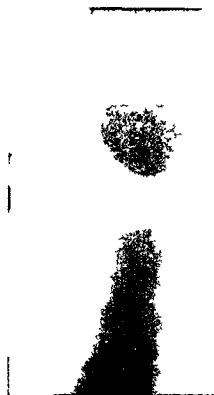


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It immediately disappears. The author has perfectly confirmed this by X-ray study of the immediately and remotely following operation. On the other hand the enlargement of the pelvis by the graft is a permanent enlargement. The only alternative is caesarean section.

The iliac graft is apparently the only method which effects permanent enlargement of pelvis to small fetal delivery. It is particularly applicable to the juxtamajor type.

TECHNIQUE

The technique is shown in Figures 1 to 6. The ends of the graft are mortised into the symphyses by the author's ivory technique used in other bone grafting operations. In the enlargement of the pelvis the strength of the graft is exceedingly important. Great care must be taken that it is sufficiently strong to withstand the pressure of the bones as they attempt to get back to their former position.

STENOSING FIBROUS TENDOVAGINITIS OVER RADIAL STYLOID (DE QUERVAIN¹)

H. CHRISTEL C. SCHNITZER, M.D., MILWAUKEE, WISCONSIN

For several years my attention has been directed to an interesting condition at the wrist concerning which I could find no enlightenment in American literature. The relative frequency of the condition and the striking similarity of all cases in their symptoms and physical findings make it seem evident that this was a definite clinical entity worthy of careful study and analysis.

The patient with this condition invariably complains of pain at the wrist more or less localized to the distal region of the radial styloid and radiating into the hand and up the forearm. There is history of a gradually developing pain at the site of the radial styloid usually without any precipitating trauma. This pain becomes severe in the course of weeks or months that completely disables the wrist and ensues. Occasionally the pain assumes a neuralgic character in its very severe attack. Abduction and extension of the thumb are accompanied by severe pain and pressure over the radial styloid is exquisitely tender. Practically all of the patients that have come under my care have been seen previously by one or more physicians who have variously diagnosed the condition as rheumatism, neuralgia and neuritis usually prescribing heat, saline electricity and rest. Despite the measures the symptoms have become increasing severe finally incapacitating the wrist for further use.

Physical examination reveals definite swelling in the region of the radial styloid (Fig. 1) extremely tender to pressure. Abduction and extension of the thumb are very painful in many

instances the patients being unable to perform this motion at all. Even gripping and ulnar and dorsiflexion produce pain over the involved region. Frequently a gristle like thickening can be felt under the skin while at times the periosteum of the underlying radius seems thickened. There is never any local heat, redness, infiltration or crepitation in the tendon sheath on motion.

It is interesting to note that all the pathology occurs at the point where the abductor pollicis longus and extensor pollicis brevis tendons pass under the superficial dorsal carpal ligament through the osteofibrous canal immediately overlying the radius. Because of the fact that these muscles arise on the dorsal surface of the forearm as extensors and curve around the distal end of the radius to become abductors of the thumb (Fig. 2) they are exposed to increased friction at this site. Likewise in consequence of their superficial position between the bone and skin they become exposed to more frequent trauma than other tendons.

This condition was first described in 1895 by de Quervain of Basle, Switzerland who reported 5 cases in the *Correspondenz Blatt fuer schaefer Aerzte*. He saw his first case under Professor Kocher at the Bern Klinik in 1893. Subsequent to de Quervain's first paper a considerable number of German and French clinicians reported additional cases investigating the condition quite exhaustively. The most comprehensive study was made by Alfons Eschle of Basle in 1924 who tabulated the 110 cases previously reported in the literature and added 19 more which had come under his own observation.



FIG. 1. Photograph of normal and involved wrist showing swelling over radial styloid in the latter.

Although I have personally seen and treated between 25 and 30 cases in clinical and private practice I have been able to collect the records of only 15 of these. This makes a grand total of 144 cases. In 135 of these where the sex was reported 119 were women and 14 men. Out of 89 where the side was noted 47 were right 44 left and 4 bilateral. These patients ranged in age from 15 to 75 years the majority however being between 35 and 55. Housewives and maids constituted the largest vocational group there being 81 with this classification. Further there were 7 farm women 4 factory workers 3 nurses pianists 1 milliner 1 plasterer 1 hairdresser 1 laborer and 1 architect.

Although the exact *etiology* of this condition is not clear there seems to be more or less agreement among the various authors that *excessively monotonous* use of the involved tendons is the most commonly evident cause. The incidence of the disease practically exclusively among workers who use their thumbs a great deal seems to substantiate this view. In some instances a single direct blow to the exposed tendon sheath has been the sole etiological factor while in other cases injury followed by excessive use of the thumb has been responsible. A few authors have noted a rheumatic predisposition in some of their cases but this is by no means constant. Lues and tuberculosis have been definitely ruled out as bearing no relationship to this condition. The primary cause then as far as can be determined is a mechanical rubbing of the abductor pollicis longus and extensor pollicis brevis tendons over the rounded distal end of the radius. This becomes quantitatively increased by increased force or frequency and produces an oedema of the tendon sheath and results in a vicious circle increasing the friction and causing the lumen of the tendon sheath to become narrowed. Trauma qualita-

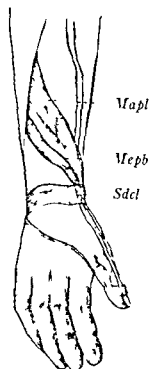


FIG. 2. Sketch showing origin and insertion of abductor pollicis longus and extensor pollicis brevis. Note how tendon curves around radial styloid in common tendon sheath under peculiar dorsal carpal ligament. *Mapl* abductor pollicis longus muscle *Mepb* extensor pollicis brevis muscle *Sdel* superficial dorsal carpal ligament.

tively influences the irritation by increasing the oedema or changing the underlying bone.

According to all the authors who have previously written upon this subject X-ray examination has consistently failed to reveal any change in the underlying bone. My own cases have corroborated this observation with one or two exceptions. Figure 3, a roentgenogram of the normal and involved wrists, reveals some deposition of lime salts over the radius at the site of the fibrocartilaginous disc of the diseased tendon sheath. This suggests a probable extension to the periosteum of the bone in the nature of a proliferative reaction such as one might expect to see following trauma or inflammation.

Figure 4 shows a similar change but to a lesser extent in another case. These bone changes might be ascribed to the extension of irritation to the periosteum or may be only structural variations in normal bones.

No relationship has been established between this disease and syphilis. All the blood Wassermann tests in my own cases have been negative as is true of all the cases previously reported in the literature. Likewise no evidence of tuberculosis has been noted in the few cases. Although tuber-



Fig. 1 (left) Normal hand. Fig. 2 (middle) Dupuytren's contracture. Fig. 3 (right) Dupuytren's contracture. The fingers are contracted towards the palm, and the skin on the palm is thickened and fibrotic.

cutaneous synovitis is a well known disease and the synovitis of the olecranon bursa has never been known to be tuberculous and does not usually follow the course of the tuberculous

The pathology of this condition has been studied very carefully by Kocher, Le Quervain, Kessler, Vacher, Huick, Nussbaum, Flückiger, and Schle. It was Kocher who first named the condition "stenosing tendinitis" or "tenosynovitis". The fibrous thickening which he noted in the middle layers of the tendon sheath. He looked upon the condition as a "proliferative function" brought about by an "injury" in the same class with sprains, lacerations, etc. According to Nussbaum, the normal tendon sheath is composed of 5 layers. The inner layer is the parietal part of the same tissue which covers the tendons (visceral layer) and is composed of 2 strata of flat or cubical cells with spindle shaped or round nuclei. This layer frequently has finger like processes and contains fine lymph vessels without muscle wall. The second layer is composed of loose connective tissue containing nerves and blood vessels. Then follow three firm layers of connective tissue, the inner layer with fibers

running parallel to the outer across the blood supply, the latter being the wider of the two. The fifth and last layer is composed of loose connective tissue with nerves and blood vessels. Whereas grossly the common tendon sheath of the abductor pollicis longus and extensor pollicis brevis is tendinous and normally a thin colorless transparent membrane in this disease it is thickened non-transparent and cuts like gristle. The canal is narrowed so that in some cases it is difficult to pass a thin probe through it. When cut the sheath looks milk white, the inner surface lustrous yellow to red in color, here and there like velvet like. While at times the sheath itself may be thickened to 4 times its normal depth, the tendons themselves show no changes. Occasionally the 2



Fig. 4 (left) Normal hand. Fig. 5 (middle) Dupuytren's contracture. Fig. 6 (right) Dupuytren's contracture. The fingers are contracted towards the palm, and the skin on the palm is thickened and fibrotic.

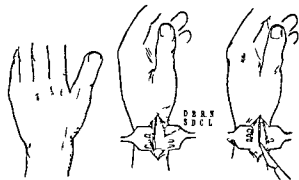


Fig. 7 (left) Normal hand. Fig. 8 (middle) Dupuytren's contracture. Fig. 9 (right) Dupuytren's contracture. The fingers are contracted towards the palm, and the skin on the palm is thickened and fibrotic.

TABLE I—SYNOPSIS OF FIFTEEN CASES OF DE QUERVAIN'S DISEASE PERSONALLY
 REVIEWED

No	Name	Age	Occupation	Side	Duration	Cause	Treatment		Result
1	V F	50	Milliner	Left	1 month	Arthritis	Cast 2 wk	Further Rx refused	Unimproved
2	I B	30	Laborer	Right	5 months	Excessive use	Cast 6 weeks Operation		Unimproved Cured
3	C B	48	Architect	Right	1 week	Excessive use	Splint 1 week	Further Rx refused	Unimproved
4	M R	15	Student	Left	1 year	Bad ball train	Cast 4 wks		Cured
5	I B	1	Dreasmaker	Right	1 month	Seizure	Cast 6 weeks		Cured
6	C C	16	Student		1 month	Uncertainties	None		
7	K F	33	Housewife	Right	6 months	Excessive use	Cast 6 weeks		Cured
8	S T	50	Housewife	Left			Cast 6 weeks		Cured
9	V J	25	Housewife	Left	3 weeks		Cast 6 weeks		Cured
10	C W	47	Housewife	Right		Arthritis	Cast 1 week		Cured
11	F D	40	Nurse	Right	1 week	Excessive use	Splint 6 weeks		Cured
12	C P	31	Nurse	Right	2 months	Excessive use	Cast 6 weeks		Cured
13	V B	40	Housewife	Right	2 months	Excessive use	Cast 6 weeks Operation		Unimproved Cured
14	C F	45	Nurse	Left	3 months	Lifting in child mother	Cast 6 weeks	Further Rx refused	Unimproved
15	J M	53	Housewife	Left	3 months	Fall on wrist	Untreated		

tendons may be adherent to each other with a thin fibrous band. Three of Keppeler's cases showed firm adhesions between the tendons and the sheath. All the authors seem to agree that the tendon sheath is too narrow for the tendons.

Histologically most of the cases fall into one of two groups according to Nussbaum. Group 1 in which the majority of them he shows a connective tissue proliferation in the sheath 3 fold to 4 fold. There is no fixed direction of the fibers and the endothelium and its substratum are frequently absent. In the second group the blood vessels and nerves loosely held in the outer layers of the sheath are surrounded by round celled infiltration. Many sections in this region show small irregular necrotic areas. On the inner side of the sheath the blood vessels are increased. The occlusion of the lumen of the sheath is often directly produced by necrotic masses. This histological evidence would point to the fact that we are here dealing with a reaction to trauma or excess use which is not inflammatory. Some factor is responsible for the stimulation of the fibrous tissue growth in the connective tissue layers of the tendon sheath.

In the treatment of this condition a wide field of therapeutic aids has been tested practically all of them to no avail except prolonged immobilization and surgery. Heat, electricity, splints, rest, massage, internal medicaments, etc., have been of no avail. Practically all of the European writers who have described this condition are agreed that conservative measures do not yield encouraging results. In my own practice I have employed a plaster of Paris cast to the thumb and wrist with the thumb in full extension and abduction (Figs. 5 and 6). Such casts when allowed to remain on from 4 to 6 weeks produced a complete remission of symptoms in 7 out of 10 cases. Immobilization must be absolute and sufficiently prolonged to permit complete resolution of the pathological changes which have taken place in the sheath. In those cases where the fibrous stenosis has become too advanced to respond to immobilization alone, surgery has provided a simple and effective solution to the disability. The operation proposed by de Quervain and successfully used by a number of European surgeons is as follows: Under a local anesthetic a linear incision about 1½ inches long is made over

the distal end of the radius through the skin and subcutaneous tissue. Overlying the superficial dorsal ulnar ligament is a small branch of the radial nerve which should be retracted. A cut is made through the carpal ligament immediately over the tendon sheath and then the thickened sheath is split for a distance of about 1 inch. The skin is closed and the wound dressed without a cast. Figures 7, 8 and 9 show the steps of the operation. Active motion can be undertaken within a few days and full restoration of function may be anticipated within 2 or 3 weeks. Of 66 cases collected by Leschle which were treated surgically in this manner 65 were cured and 1 improved. I have resorted to surgical division of the common tendon sheath in 2 cases both of which were cured.

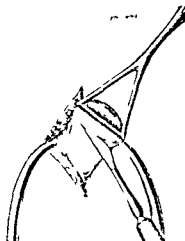
Table I gives a summary of the 15 cases from my own records and indicates the treatment rendered and results obtained along with other pertinent data. It will be seen from a cursory examination of this that the correct employment of the plaster cast has afforded cures in 70 per cent of the cases thus treated and that this treatment is to be recommended in the cases seen fairly early.

To summarize briefly we are here dealing with a clinical entity not previously described in American literature or textbooks known as de Quervain's disease. This is a passive function hypertrichy of the fibrous layers of the common sheath of the ulnar flexor pollicis longus and extensor pollicis longus tendons causing a stenosis of the sheath over the radial styloid and impairment of function of the thumb. The pain over the radial styloid may be severe as to produce complete disability at the wrist. The condition is a chronic one and requires not only complete immobilization

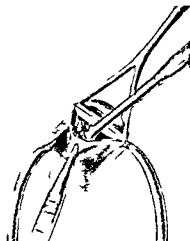
of the thumb and wrist in a cast from 4 to 6 weeks or in late cases surgical splitting of the stenosed tendon sheath.

BIBLIOGRAPHY

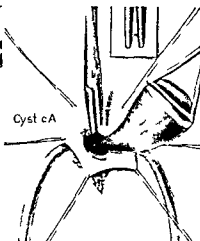
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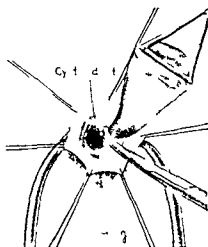
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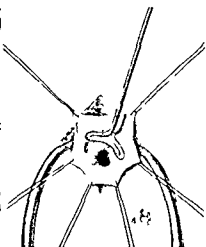
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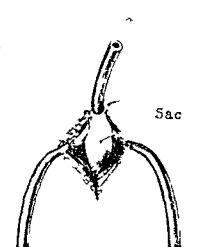
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Ordinarily, however, the procedure is easier with a moderately full vesicle.

When the resistant strand of fibrous tissue interferes with the stripping process they are cut with scissors close to the gall bladder in order to avoid button-holing the peritoneal sleeve or lacerating the liver. If the strand be large a Cu ring silver clip should previously be applied for some of them will contain vessels running from the gall bladder to the peritoneum. Surprisingly little bleeding is encountered, however, since most of

the vessels remain on the gall bladder. Should any be torn off the bleeding points on the vesicle can be stopped by a touch with the electrocoagulator or by a silver clip. The suction dissector keeps the field clear of blood ooze from the small vessel. Near the region of the cystic duct all large strands of fibrous tissue should be doubly silver clipped before division since one of them will contain the cystic artery (Fig. 4). If the artery by chance breaks loose there is little danger since all the bleeding is within the peritoneal



Fig 8 Sutured wound with drainage tube

sleeve The blood can be removed with a sucker of adequate size and time taken to secure the vessel. If this is not possible a gauze packing kept dry with suction can be applied until coagulation occurs. In some of my experimental operations in which the cystic artery broke loose and was not secured not over 50 cubic centimeters of blood was lost.

After the cystic artery is cut the cystic duct is easily dissected out under traction. If the duct breaks off during this process no damage ensues since any leakage of bile will be carried off through the peritoneal sleeve. When the duct is freed it is clamped as low as possible tied and the vesicle removed (Fig 5). Upon release the stump retracts into the recess under the peritoneum from which the duct had been withdrawn (Fig 6).

Should there be a question of common bile duct obstruction in patients however (though this should have been ruled out by careful pre-operative examination) iodized oil can be injected into the stump of the cystic duct left rather long and roentgenograms of the ducts made (Fig 9). If it should be expedient to test the patency of the ducts before this stage is reached the gall bladder can be opened emptied of its contents and filled with iodized oil then by gentle pressure the oil can be forced down the ducts. If unforeseen obstruction is noted it can be dealt with in the usual manner if the incision is enlarged.

Finally after subperitoneal removal of the gall bladder a small rubber tube with side holes is placed in the peritoneal sleeve and brought to the outside the sleeve being collapsed about the tube and lightly tied at the point of contact with the abdominal wall (Fig 7). Thus the tube is completely peritonealized and any leakage of bile or blood into the peritoneal cavity precluded.



Fig 9 Roentgenogram of the biliary passages of a dog. Iodized oil was placed in the gall bladder and gentle pressure exerted. Cut shows a small amount of oil in the gall bladder (above) common duct full and a large amount in the duodenum (below).

The operation has been performed upon 16 dogs. Fourteen made perfect recoveries apparently showing very few effects of any kind from the procedure. Two died after the operation one of peritonitis and bile leakage in which the cystic duct had been clamped and electrically coagulated no drainage of the peritoneal sac being employed the other also not drained died of leakage of blood and bile into the peritoneal cavity through an accidental opening in the peritoneal sac. These two poor results emphasize the necessity for stopping hemorrhage before closing the wound and for subperitoneal drainage for 1 to 3 days. The 14 other dogs at necropsy showed only a few omental adhesions at the operative site.

THE QUESTION OF CLINICAL APPLICATION

The first requisite for such a procedure as has been described would be a definite diagnosis. It must be determined with reasonable certainty

that the gall bladder and not the stomach duodenum or pancreas is the organ diseased. This implies extremely careful study of the case and the application of all necessary tests including roentgenological studies of the gastrointestinal tract and frequent determinations of the icterus index over a period of one or more weeks.

In the diagnosis of gall bladder disease the history is of great significance and the ruling out of disease of other organs by appropriate tests is essential but cholecystography is the method *par excellence*. If a shadow of the gall bladder be obtained the condition of the viscus can be accurately predicted in almost every instance. A shadow definitely mottled in successive films indicates stones while contraction after feeding indicates an active musculature without marked sclerosis. This combination frequently occurs. Furthermore the very production of a shadow implies that the vesicle is active enough to empty and allow refilling indicating a non-sclerotic wall and a serosa which will readily strip away. Such a gall bladder presents the ideal case for subperitoneal cholecystectomy. The method would probably have been applicable to all the cases reported in my article on the diagnosis of gall bladder disease.

If no shadow of the gall bladder be obtained by the intravenous method of cholecystography

the gall bladder is almost surely diseased perhaps severely enough to preclude subperitoneal cholecystectomy but in many cases the failure of shadow formation is due to partial blockage of the cystic duct with stones or a gall bladder so full of stones that an insufficient quantity of the radio opaque material can enter yet in either of these cases the wall may not be sclerotic enough to prevent stripping of the serosa.

To determine whether or not this be true a small incision can be made as nearly over the fundus of the gall bladder as may be after very careful percussion and palpation with the patient under ether and the condition investigated by an exploratory lamp. If the gall bladder be found fibrotic or bound down by a mass of adhesions of course the case is unfavorable for subperitoneal cholecystectomy and the regular operation should be done. The presence of a few adhesions need not necessarily contraindicate a subperitoneal cholecystectomy. The gall bladder may be pulled up if possible and the adhesions ignored or they may be previously dissected away. I have observed that in many excised gall bladders which had had adhesions the serosa would still strip readily. Subperitoneal cholecystectomy cannot be done if the gall bladder is too friable to allow moderate traction.

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A PRACTICAL CONSIDERATION OF THE DAMAGED PELVIC FLOOR WITH A TECHNIQUE FOR ITS SECONDARY RECONSTRUCTION¹By BYRON H. GOFF, M.D., F.A.C.S., NEW YORK
Att. Surg. Wm. H. Pitt

THE operations which are commonly employed in the secondary reconstruction of the lacerated or relaxed pelvic floor are of two distinct types. The less radical type of operation which consists of a superficial denudation of vaginal mucous membrane, an inversion of the denuded portion of the rectovaginal septum, and a reconstruction of the perineum is still used by a considerable number of both gynecologists and general surgeons. The majority of operators, however, have adopted a more radical type of procedure in which some form of flap splitting of the rectovaginal septum is followed by a direct union of the anterior portions of the levator ani muscles between the vagina and rectum and by a reconstruction of the septum and perineum.

During the past decade many operations of both types have been performed according to the accepted technique by members of the staff of the Woman's Hospital, and in approximately 75 per cent of the cases the end results have been carefully observed for periods of time ranging from 1 to 5 years. The follow-up findings have thrown much light upon the relative merits of the two generally accepted methods of reconstructing the damaged pelvic floor and have clearly revealed certain objectionable features in the end results of both types of operation.

The objections to all operations in which denudations and inversions of redundant tissue are employed are (1) the impossibility of a restoration of the levator ani muscle to normal anatomical position and function by such procedures, and (2) the unjustifiable incidence of recurrent rectocele which follows their application.

In the restoration of the retracted levator ani to its normal position and function it is essential to expose its fascial covering and the superior layer of the urogenital trigone to which its fascia is attached. To do so necessitates flap splitting of the rectovaginal septum and a type of flap splitting in which the flap includes all layers of the septum from the vaginal mucosa to the rectal musculature. An examination of the accompanying anatomical charts convinces one of the impossibility of such an exposure by any form of mucous membrane denudation.

The high incidence of recurrent rectocele which follows the type of operation under consideration

is satisfactorily explained by the fact that in this type of procedure the fundamental principles which underlie a successful surgical correction of a hernia—and a rectocele is a hernia—have not been observed. In the surgical correction of any hernia it is of fundamental importance to incise all layers of the hernial sac which in a rectocele is the herniated portion of the rectovaginal septum, and to remove from the sac its content, the abnormally situated and adherent rectum in the case of the rectocele. The remainder of the correction consists of the removal of the hernial sac and the closure of the hernial opening through the use of available muscles and fascia. It is obvious that such principles are not observed in the superficial type of operation.

The more radical operations in which flap splitting and direct levator myorrhaphy are employed, though productive of generally good results in the cure of rectocele, fail in most instances to restore the levator ani to normal function. As levator myorrhaphy is usually performed, varying amounts of the fascial covered and immobilized anterior fibers of the muscle of one side are united between the vagina and rectum with a similar bundle of fibers from the muscle of the opposite side. Sutures which have been placed about the muscle bundles above the perineum are tied under a tension sufficient to hold them together until union occurs. Despite the care with which such sutures are tightened, it is extremely difficult to avoid a pressure atrophy of the included muscle fibers with the result that a more or less crescentic rigid and functionless band of scar tissue forms at the site of the junction of the muscle bundles. It is a well recognized fact that such bands of scar tissue cause dyspareunia and dystocia and are responsible for an impairment or complete loss of function in the most important fibers of the levator muscles.

In an effort to avoid the objectionable sequelae of the two conventional methods of reconstructing the injured pelvic floor the operation herein described was devised. It has been under trial by several members of the staff of the Woman's Hospital for the past 4 years and has gained a confidence which seems to warrant a preliminary report at this time. It has been based upon a recognition of the following facts concerning the normal anat-

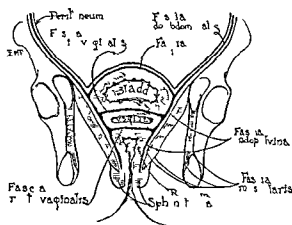
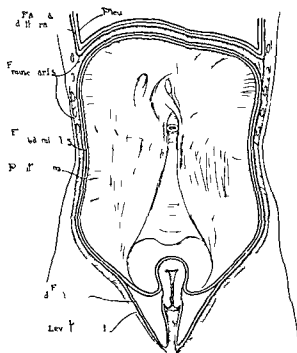


Fig. 1. Illustration of the female pelvis from a superior view. Fig. 2. Illustration of the female pelvis from a posterior view.

only and function of the pelvic floor and the changes which occur as a result of injury at the time of parturition.

NORMAL ANATOMY OF THE PELVIC FLOOR

The pelvic floor or pelvic diaphragm is formed by the levatores ani muscles, the coccygeus muscles and the fascia which surrounds them. The diaphragm thus forms almost closes the pelvic outlet and separates the pelvic cavity from the perineum which completes the closure.

The levator ani muscle, the larger and more important of the two muscles which form the muscular portion of the pelvic diaphragm, arises from the posterior surface of the pubis, the white line (or interlinea muscularis levatoris ani) and the lesser sciatic foramen. From this broad origin the fibers run laterally backward and inward to be attached to the sides and tip of the coccyx, to the fibrous raphe (ligamentum anococcygeum). It extends from the tip of the coccyx to the anus and the sides of the rectum. A few fibers of the muscle pass from the most anterior portion of the muscle between the vagina and rectum to be inserted into the perineal body.

Though the levator ani is usually regarded as one muscle it is made of three separate flat

segments. Piersol (1) in commenting upon this phase of the subject says: "There is usually to be found a dividing line across the muscle on a level with the junction of the superior ramus of the pubis with the ilium and separating those fibers which are inserted into the coccyx and the posterior portion of the fibrous raphe from those which pass to the anterior part of the raphe and the rectum. Each of the portions so separated is supplied by a separate nerve and this combined with the results of comparative anatomy shows that the posterior portion of the levator is really a muscle quite distinct from the anterior portion. It has been termed the musculus iliococcygeus. Furthermore it seems probable that the anterior portion is composed of two morphologically distinct muscles, one of which arises from the pubis and anterior part of the white line and is inserted into the median fibrous raphe, whence it is termed the pubococcygeus, while the other situated beneath the superficial to the pubococcygeus consists of those fibers which arise from the pubis and are inserted into the rectum and is termed the musculus puborectalis."

There has been considerable controversy concerning the presence or absence of fibers of the levator ani in the perineal body between the rectum and the vagina. Dissections by Martin (6) and others have proved conclusively that there are fibers of the puborectalis, the fibers of Luska which pass between the rectum and vagina to insert into the perineal body.

Of the three portions of the levator ani, the two more anterior portions, the pubococcygeus and the puborectalis, are from the viewpoint of the gynecologist and obstetrician the most important segments both structurally and functionally. In commenting upon the pubic segments Sturmdorf

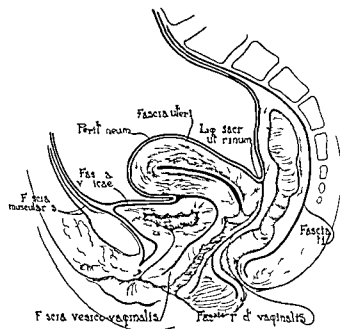


Fig. 3 Illustration in sagittal section the distribution of the fascia endopelvina about the bladder, the vagina and the rectum

(9) has said: "Their lines of origin extend for 1 $\frac{1}{2}$ inches on either side of the posterior surface of the pubic symphysis, thus equaling in width the average sternomastoid; they are twice as thick as the diaphragm, weigh one fourth as much as the external oblique, altogether presenting a muscular support exceeding that guarding the inguinal ring."

These pubic segments course almost horizontally backward and inward along the lateral vaginal wall. They converge rapidly toward those of the opposite side to become inserted into the perineal body, the rectal walls and coccygeal tendon, encircling the vagina and rectum in distinct loops.

Their median borders, which are plainly palpable through the lateral vaginal walls, a half inch or less behind the plane of the hymen, form a V-shaped interspace which embraces the introitus under the pubic arch and is termed the levator cleft (hiatus genitilis). In this cleft are the urethra, vagina and rectum.

The coccygeus muscle the flat fan-shaped muscle which completes the muscular pelvic diaphragm posteriorly, arises from the spine of the ischium and is inserted into the sides of the sacrum and coccyx. It is of no practical importance to the gynecologist.

The pelvic fascia the fascia of the pelvic diaphragm is a continuation of the iliac fascia. It descends over the anterior surface of the pyriformis, the upper portion of the obturator internus and the superior surface of the levator ani and

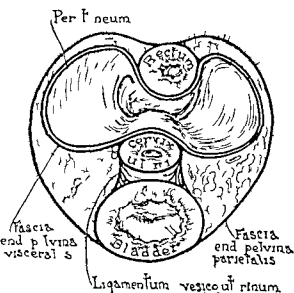


Fig. 4 Illustration in a cross section made at a level of the rectum showing the distribution of the fascia endopelvina

coccygeus muscles. That portion of the fascia which covers the superior surface of the pelvic diaphragm is termed the superior fascia of the pelvic diaphragm (fascia diaphragmatis pelvis superior).

From the line of origin of the superior fascia of the pelvic diaphragm the pelvic fascia continues downward to cover the mesial surface of the lower portion of the obturator internus. This fascia the obturator fascia is attached to the tuberosity and ramus of the ischium and the inferior ramus of the pubis.

Along the line of union of the superior fascia of the pelvic diaphragm and the obturator fascia

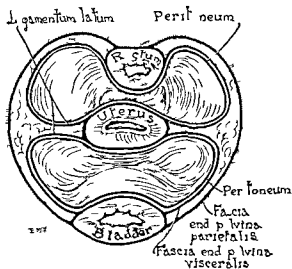
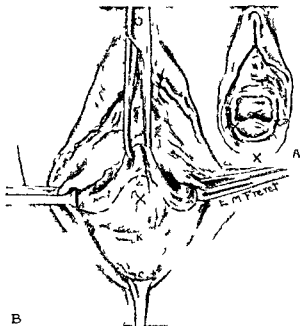


Fig. 5 Illustration in a cross section made at a level of the corpus uteri showing the distribution of the fascia endopelvina



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there is a curved thickening in the pelvic fascia which extends from the posterior surface of the os pubis to the spine of the ischium or in some instances to the iliopectineal line. This thickening is termed the white line (arcus tendineus musculi levatorum) and from it a large portion of the levator ani takes its origin.

From the white line a thin layer of fascia extends over the inferior surface of the pelvic diaphragm and is termed the inferior fascia of the pelvic diaphragm (fascia diaphragmatis pelvis inferior).

The superior and inferior fasciae of the pelvic diaphragm form a compartment for the levator ani and coccygeus and both fuse along the anterior border of the levator ani with the superior layer of the urogenital trigone (triangular ligament). Posteriorly and mesially each of the two layers of the fascia of the pelvic diaphragm fuses in the sagittal plane with a corresponding layer from the opposite side.

In the above description of the pelvic fascia it is apparent that the term pelvic fascia applies only to the fascial coverings of the pelvic muscles.

Fascia endopelvina. As the pelvic muscles are surrounded by layers of the pelvic fascia so the pelvic viscera are surrounded by sheaths of a thin fascia which according to the descriptions in standard textbooks on anatomy originate from a

common curved thickening in the superior fascia of the pelvic diaphragm. This arcuate thickening extends from a point a little to the outer side of and slightly above the lower border of the symphysis pubis to the spine of the ischium and is termed the arcus tendineus of the pelvic fascia. Upon the origin of the visceral layers of the pelvic fascia all textbooks agree. On the contrary Halban (4) who has made a careful and convincing study of the fasciae of the pelvis disagrees not only with the descriptions in standard works on anatomy but also with those in the writings of gynecologists.

Halban describes a layer of thin fascia which is situated between the parietal peritoneum and the fascial coverings of the abdominal muscles and terms it the fascia endoabdominalis (Fig. 1). This fascia extends over the entire abdominal parietes and thoracic diaphragm, sends layers to the abdominal viscera and descends into the pelvis to become the fascia endopelvina (Fig. 2) which is composed of a parietal and visceral portion. Halban contends that the fascia endopelvina is a distinct fascia which is not a part of the fascial sheaths of the pelvic muscles. He emphasizes the fact that the parietal portion of the fascia endopelvina though lying upon and attached to the muscle fascia by connective tissue is distinctly separable from it. It is apparent therefore that he recognizes two distinct fasciae in the pelvis: the muscle fascia and the fascia endopelvina, the distribution of which is clearly illustrated in the accompanying diagrams (Figs. 1, 2, 3, 4, and 5).

To the various layers of the visceral portion of the fascia endopelvina are given definite names which are indicative of their situation. It is important to bear in mind that they are all parts of the same fascia and all fuse laterally.

In a consideration of cystocele and rectocele the layers of the fascia endopelvina which are of greatest importance are the vesicovaginal layer which lies between the bladder and the vagina and the rectovaginal layer which lies between the rectum and the vagina. It is to be noted that these layers fuse at the sides of the vagina to form a perivaginal sheath which is situated just without the vaginal musculature. Halban has given to this sheath the term *perivagina fibrosa*.

Authors who have written upon the subjects of cystocele and rectocele have frequently used terms which are vague and misleading among them the terms *fascia propria* of the vagina and rectum. These terms are poor ones in that they lead one to believe that there are individual fasciae about the vagina and rectum without indicating their origins or situations. Halban's terms

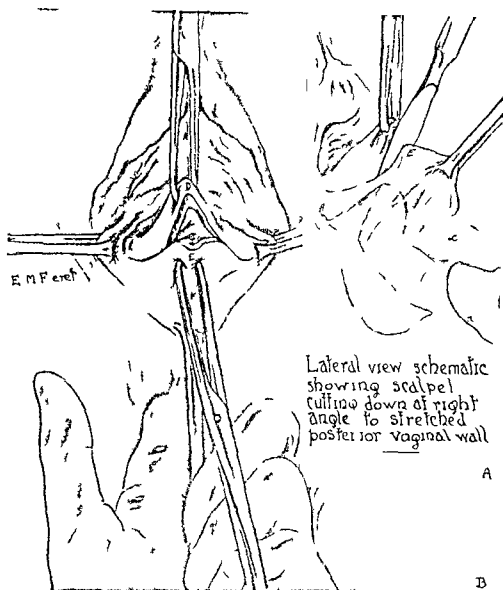


Fig. 7. Illustrating the method of making the initial incision which passes through all layers of the septum and leads into the rectovaginal cleavage plane.

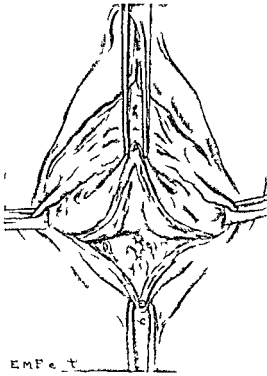
are definite and descriptive and should be universally adopted.

The perineum. The term perineum is applied to that lozenge shaped region at the pelvic outlet which is bounded by the symphysis pubis, the coccyx, the greater sacrospinous ligaments, the ischial tuberosities and rami, and the pubic rami. A straight line drawn between the anterior borders of the ischial tuberosities divides the region into an anterior urogenital triangle and a posterior rectal triangle.

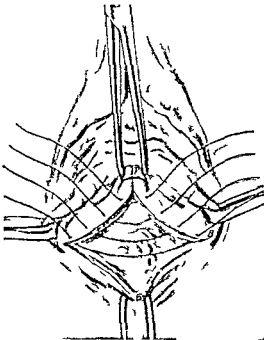
The urogenital triangle—to the gynecologist and obstetrician, the more important of the two perineal triangles—is bounded by the symphysis pubis anteriorly, by the rami of the pubes and ischia laterally, and by the posterior margins of both layers of the urogenital trigone posteriorly,

where they become continuous with each other and with the fascia of Colles.

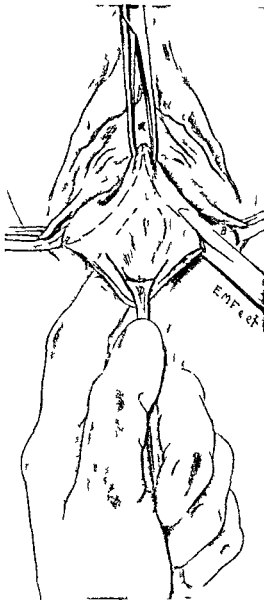
Extending across the urogenital triangle is a fascial plane, the urogenital trigone (triangular ligament) which forms a complete diaphragm over the anterior half of the perineum except the urethral opening and the vaginal cleft. This important fascial structure is formed by the deep fascia of the perineum and is composed of two layers, the superior and inferior. Anteriorly both layers are attached to either edge of the inferior border of the pubis, laterally to the rami of the pubes and ischia, and posteriorly they unite and fuse with the deep layer of the superficial perineal fascia—the fascia of Colles. Laterally both layers of the trigone are continuous with the obturator fascia, and above the superior layer fuses at the



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vaginal cleft with the fascia about the levator ani and with the fascia which surrounds the vagina the fascia endopelvina. Along this line of fusion the inferior layer of the triangle fuses with the superior layer. Robert Frank (3) called attention to the important facts in 1917

The urogenital trigone in the female is perforated by the vagina by the urethra and by a small opening just behind the subpubic ligament through which passes the dorsal vein of the clitoris. Immediately behind the venous opening

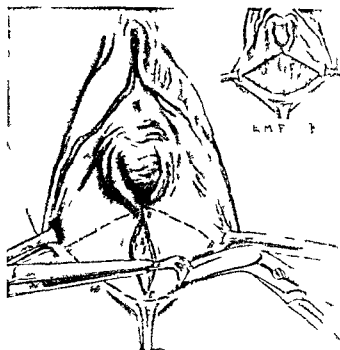


Fig 11 The denudation of the perineum is made with an Emmett scissors

there is a thickened portion of the trigone termed the transverse ligament of the pubis

Between the superior and inferior layers of the urogenital trigone there is a closed space the deep perineal interspace This space contains branches of the internal pudic vessels and nerves and a thin muscular sheet which is composed of the deep transversus perinei muscle posteriorly and fibers which correspond to the compressor urethrae in the male anteriorly The deep transversus perinei arises from the tuberosity of the ischium passes behind the vagina and inserts into the central tendon of the perineum The anterior fibers of the muscular sheet are attached in the central tendon of the perineum and pass forward closely encircling the vagina and either surround the urethra or pass in front of it in the interval between urethra and transverse ligament This muscular sheet has been termed the urogenital sphincter

Over the urogenital triangle there is a superficial fascia the superficial perineal fascia which is composed of two layers a superficial and a deep layer The superficial layer which is fat filled is continuous anteriorly and laterally with a corresponding layer on the abdominal wall and thighs The deep layer the fascia of Colles which is membranous is continuous anteriorly with Scarpa's fascia is attached laterally to the rami of the pubes and ischia and posteriorly blends with the urogenital trigone

Between the inferior layer of the urogenital trigone and the fascia of Colles there is a tri-

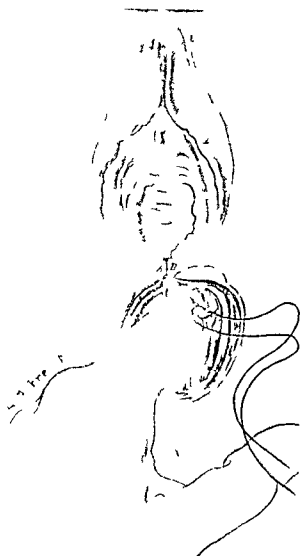


Fig 12 Sutures pass through the entire thickness of the perineum and include the fascia about the levator ani where it is attached to the urogenital trigone Sutures and pass on the same tissue

angular space the superficial perineal interspace which contains the superficial perineal muscles the long pudendal nerves the glands of Bartholin the crura of the clitoris the vestibular bulb the ischioavernosus and bulbocavernosus muscles and the superficial transversus perinei muscles attached to the ischial tuberosities and inserted into the central tendon of the perineum In a practical consideration of the damaged pelvic floor the superficial perineal muscles except the transversus perinei and sphincter ani are of little importance

When we consider the anatomy of the perineum it is important to distinguish between the perineum as described above and the perineal body that triangular fibromuscular mass which separates the vagina from the rectum and anus

Under a description of the urogenital triangle of the perineum the sphincter ani should be included

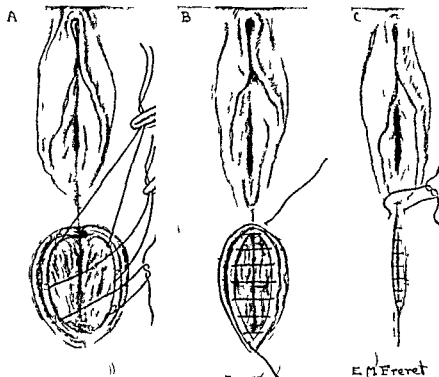


Fig. 3. After the dissection of the levator ani muscle, the rectum is shown in its normal position, and the levator ani muscle is shown in its normal position.

This important muscle arises from the coccyx and from the ligamentum anococcygeum. It passes forward and around the anus to insert into the superficial perineal fascia and the central tendon of the perineum. Anteriorly its fibers may join those of the transversus perinei and sphincter agni. The central tendon of the perineum, which has been frequently mentioned, is located in the midline of the perineal body in front of the anus. It is the tendon of insertion for the following muscles: the sphincter ani, the transversus perinei superficial and deep, and the sphincter vaginae.

FUNCTION OF THE PELVIC MUSCLES AND FASCIAE

The levator ani. In considering the function of the levator ani muscle it is important to remember that it is in reality composed of two muscles. The posterior portion of the muscle, the iliococcygeus from the gynecological viewpoint, is relatively unimportant, as in woman its function is merely to lend the coccyx forward and to assist feebly the anterior portion of the muscle in its function. The pubococcygeus and puborectalis, the two groups of fibers which compose the anterior portion of the muscle, are the essentially important segments.

In commenting upon the function of the anterior portion of the levator, Robert Dickinson ()

has said: "I venture to affirm that there is no considerable muscle in the body the form and function of which are more difficult to understand than those of the levator ani, and about which such nebulous impressions prevail. One commonly meets with the idea that the levator is a kind of muscular funnel tapering to the anus and serving to pull it directly upward after defecation. This is absolutely untrue. The muscle rather resembles a horseshoe, a sling attached to the pubes in front, its sweep reaching horizontally backward to encircle like a collar the rectum and vagina. Its action in woman is to drag the lower end of the vagina and rectum forward, level to the symphysis."

In a detailed description of the anatomy and physiology of the levator ani, Sturmdorf has clearly summarized its functions in the following statement: "Concisely stated, the levator ani diminishes the force of intra-abdominal pressure upon the pelvic contents by deflecting the direction of that pressure, augments the resistance to pressure by closing the uterovaginal angle, and obstructs the pelvic outlet against the pressure by compressing the vaginal canal. It is the tensor of the pelvic fascia, the antagonist of the diaphragm and

the abdominal muscles contracting when the opposing muscles contract and relaxing when they relax. When intact it maintains the equilibrium of the pelvic organs when its integrity is impaired equilibrium is disturbed.

Pelvic fascia. The pelvic fascia as that term is here used forms sheaths for the pelvic muscles and through its attachments fix them in their normal positions.

Fascia endopelvicina. The function of the fascia endopelvicina has been a subject about which there has been much controversy. Equally eminent authorities have held conflicting views concerning its importance. With others Martin has contented that the pelvic organs are held in normal position principally by the fascia endopelvicina and attributes to the pelvic muscles a relatively unimportant role in their support. On the contrary Halban and Tandler (5) who have made extensive studies of the subject contend that the pelvic muscles through their contractile force are principally responsible for the support of the pelvic viscera though they attribute to the fascia endopelvicina an important role in the mechanism of pelvic support.

Regardless of either theory it is untenable to believe that the fascia supports the pelvic organs through sheer tensile strength for it does not have sufficient strength to withstand the more or less constant strain of intra-abdominal pressure.

The more logical theory is that of Halban and Tandler in which the fascia endopelvicina is considered as a fascial sheath surrounding completely the uterus, bladder and rectum and fixing the structures in their normal positions but allowing a normal degree of mobility. This fascial sheath plays a part in resisting the force of intra-abdominal pressure and gravity but that part is relatively less important than that of the muscles of the pelvic diaphragm which through their contractile force give the principal support to the pelvic viscera. It is obviously of the greatest importance that in operating for the correction of uterine prolapse, cystocele and rectocele the surgeon keep clearly in mind this theory which does not recognize the fascia endopelvicina and the pelvic muscles as mere anatomic buttresses against displacement of the pelvic organs but which especially stresses the importance of the pelvic musculature in their support.

To the theory of Halban and Tandler there are antagonists who constantly cite as evidence against the theory cases in which there is marked levator impairment without descensus of the uterus. When analyzing such cases one must not lose sight of the fact that such patients usually

have a marked impairment of the abdominal muscles which play an important part in the production and maintenance of intra-abdominal pressure. The impairment in the force which the muscles usually exert is a result of pregnancy and in most instances is of a degree sufficient to equalize the impairment in the function of the levator. The levator in such cases though in a relatively inefficient condition functionally is still able to maintain its influence in the support of the pelvic organs because of the reduced intra-abdominal pressure which it has to antagonize.

Perineum. The perineum through the attachment of the urogenital trigone to the bony pelvic girdle constitutes an anchorage for the levator ani. The pelvic fascia and the fascia endopelvicina at the pelvic outlet. The superficial muscles of the perineum have as their chief function the fixation of the central tendon of the perineum.

CONDITIONS OF THE PELVIC FLOOR CAUSED BY PARTURITION

When the conditions of the pelvic floor which are caused by parturition are discussed it is important to derive clearly the meaning of the term *pelvic floor*. In the present instance it is desirable to have it include not only the musculofascial pelvic diaphragm but also the rectovaginal septum and the perineum. It does not however include the vesicovaginal septum and the tissues which form the floor of the cul-de-sac of Douglas.

The conditions which result from injury to the pelvic floor at the time of parturition may be classified as follows: (1) general relaxation of the pelvic floor; (2) rectocele; (3) injuries of the levator ani and its fascia; (4) injuries of the perineum.

General relaxation of the pelvic floor. Every gynecologist is consulted by patients who complain of pelvic discomfort from a partial loss of normal tone in the vaginal septa, the levator ani and the perineum, a condition which is a result of labor in individuals whose tissues do not involute properly or of a prolonged second stage of labor in which the normal tissues have been subjected to pressure and distention without laceration. An analogy can be drawn between such a condition in the pelvic fasciae and musculature and that which is so frequently seen after pregnancy in the muscles and fasciae of the abdominal wall. General relaxation of the pelvic floor is an entity with which the gynecologist has to deal and one which calls for operative correction in certain cases.

Rectocele. Rectocele may be defined as a hernial protrusion of the rectum into the vagina always a result of injury to the rectovaginal septum at the time of parturition.

The injury of the septum which is the fore runner of a rectocele is not a constant one. In an occasional case it may occur at a point near the cervix; in other cases it may occur midway but in the large majority of cases occurs at or near the junction of the rectovaginal septum with the urogenital triangle. The laceration may occur in the midline or near both vaginal sulci. Regardless of its situation the resulting rectocele always protrudes symmetrically in the midline of the vagina.

An examination of a microscopic section from the normal rectovaginal septum reveals the fact that it consists of a mucous membrane composed of squamous epithelium with its tunica propria, a circular muscular layer, a longitudinal muscle layer outside of which there is the rectovaginal layer from the fascia endopelvina. If this arrangement of the tissues is kept in mind the injury essential for the development of a rectocele is obviously one which involves the rectovaginal fascia, the fascial partition between the rectum and the vagina. Following the injury to the fascia and the retraction of the lacerated edges intra-abdominal pressure forces the rectum into the hernial opening and gradually develops a hernial protrusion into the vagina.

In the course of the development of a rectocele the rectal wall dilates and becomes abnormally attached in the sacculite vaginal wall. As the protrusion increases in size nature makes an unsuccessful effort to correct or stop the development through a general hypertrophy throughout the vaginal muscular and muscular layers. The marked thickening of the coverings of a large rectocele of long standing is apparent even in a gross examination of the tissues.

An inspection of Figure 1 convinces one of the possibility of vaginal lacerations which pass through all layers of the septum and through the rectovaginal fascia with the subsequent development of a rectocele but with no injury to the fascial covering of the pelvic diaphragm and therefore no injury to the levator ani muscle. This is a point of importance as it has been generally believed that sulcus injuries necessarily involve the levator ani and its fascia.

Injuries of the levator ani and its fascia. Text books on obstetrics usually contain vivid illustrations of lacerations in the levator ani resulting from spontaneous labor. Such illustrations are in most instances misleading for the injuries which they depict are seldom if ever encountered by the most competent observers in the routine of obstetric practice. Sturmdorf (8) who made careful studies of the injuries to the pelvic floor due to childbirth wrote in 1913 as follows: "I

have never been able to demonstrate in either recent or old lacerations of the pelvic floor the rupture of the fibers of the pubococcygeus that is so graphically pictured in many textbooks and do not believe that it takes place except in badly executed forceps delivery. After an unusually extensive study of dissections of the levator in cadavers and living subjects Sturmdorf holds a similar opinion.

The common injury to the levator ani and its fascia which occurs in both spontaneous and operative deliveries is one in which the levator fibers normally inserted into the perineal body are lacerated in conjunction with the urogenital trigone usually in the midline of the body.

In poorly executed operative deliveries however the levator bellies may be actually lacerated either transversely or longitudinally near the origin of the muscle or at a point midway between origin and insertion. When such lacerations occur it is not uncommon to see fat from the ischio-rectal space protrude through the rent in the muscle.

The remote result of injury to the levator is by no means constant. If the more usual midline injury has occurred the muscle in its retracted position may become markedly hypertrophied as a result of an attempt on the part of nature to compensate for the impairment due to the injury. If on the contrary the muscle fibers have actually been lacerated transversely the retracted portions may undergo an atrophy of a degree which will make difficult if not impossible a satisfactory reconstruction of the pelvic floor. In either case the levator is no longer able to perform its function adequately in the resistance of the intra-abdominal pressure and in the maintenance of pelvic support.

Injuries of the perineum. When an attempt is made to reconstruct the lacerated perineum it is of the greatest importance to keep in mind that to the deep perineal fascia or the urogenital trigone the layers of the fascia about the vagina, the levator ani and the rectum are attached. It is apparent therefore that any injury to this important fascia will necessarily involve the structures for which it forms an attachment.

The perineum may be lacerated completely or an incomplete laceration which reaches as far as the sphincter ani may occur. It is with the latter class of injuries that the present article deals.

The site of the injury of the perineum is variable. All obstetricians are familiar with the simple straight midline laceration which passes through the median raphe of the perineum. This type of injury is notorious for the ease with which it heals and because levator impairment and rectocele

seldom follow it. The more serious type of injury is that which passes to one or both sides of the midline and which involves the perineal muscles and fascia especially the lateral portion of the urogenital trigone. Such injuries even when primary repair has been performed often result in permanent damage to the structures involved.

The result of an injury to the lateral portion of the urogenital trigone may be a rectocele or distasis of the levator or both. When such an injury occurs the rectovaginal fascia is usually torn from its attachment to the trigone and regardless of the care with which the repair is attempted a rectocele in the lower one third of the vagina is very likely to result. Such an injury results as a rule in the lateral retraction of the injured portions of the trigone and the levatores which are attached to its superior layer. When retraction occurs the levator cleft (hiatus genitalis) is converted from a V shaped space to a U shaped gap and the anterior margins of the levator muscles become almost parallel to each other.

In view of these facts it follows that the reconstruction of the damaged pelvic floor in which a rectocele has developed consists of three distinct operative procedures: correction of rectocele, the restoration of the levator ani to normal position and function, and the reconstruction of perineum.

The operation herein illustrated consists of the following steps: (1) incision of the rectovaginal septum, (2) removal of the rectum from the herniated portion of the rectovaginal septum, (3) excision of the herniated portion of the rectovaginal septum, (4) closure of the hernial opening in the rectovaginal septum, (5) denudation of the perineum, (6) replacement of the levator ani and reconstruction of the perineum.

1. Incision of the rectovaginal septum. In practically all flap splitting operations on the pelvic floor the initial incision is made along or close to the junction of vaginal mucosa and the perineal skin. The flap is elevated either by scissors being plunged into the tissues between the rectum and vagina or by a more cautious nibbling dissection with scalpel or scissors. Both methods are objectionable because they do not make for a clean cut and accurate entrance into the natural cleavage plane which lies between the rectum and the rectovaginal fascia. Very frequently when the scissors are plunged into the tissues the natural cleavage plane is missed and a false plane of cleavage is produced with the result that a part of the septum or fascia remains on the rectum. The same error is also easily made in the more cautious dissection which unnecessarily traumatizes the tissues and causes an unnecessary blood loss.

The importance of accurately entering and following natural cleavage planes has been emphasized by Bissell (1) who in an article published in 1918 on a fascial lifting operation for rectocele stresses the fact that there is a natural cleavage plane between the rectum and rectovaginal fascia which he terms a cellular area along which the rectum is easily separated from its attachment to the fascia. At the same time he describes the method by which he reaches the cleavage plane as follows: The mucous membrane of the perineum is first removed and the rectovaginal fascia exposed. This fascia is incised at about where it merges with the perineum or its remaining structures. When the fascia is incised a cellular area is entered which area constitutes the line of demarcation between rectum and vagina.

In the procedure herein described the primary incision is neither made at the mucocutaneous junction of the perineum nor at the junction of the septum and the perineum but is placed at a point centimeters above the junction of the septum and the perineum because at this level there is little or no scar tissue encountered and the rectum which has been pulled downward while the septum has been elevated by clamps (Fig. 7) is barely attached to the underside of the rectovaginal fascia by a delicate areolar tissue. The entrance into the rectovaginal cleavage plane is therefore made with greater ease than when the incision is placed at a lower level where there is the greatest amount of scar tissue and where the rectum is more firmly adherent to the septum and perineum. The incision passes through all layers of the septum to the musculature of the rectum. As the scalpel passes through the septum the cleavage plane is recognized by the presence of the delicate areolar tissue which attaches the rectum to the rectovaginal fascia.

2. Removal of the rectum from the herniated portion of the rectovaginal septum. When the initial incision in the rectovaginal septum is completed the rectum is separated from its abnormal attachments by a finger covered with gauze. The separation is carried well beyond the area through which the rectum has protruded (Fig. 8).

3. Excision of the herniated portion of the rectovaginal septum. The outline of the excised portion of the rectovaginal septum will depend in each case upon the location and the extent of the hernial protrusion of the rectum into the vagina. In the case of a rectocele which protrudes through the lower one third of the vagina the removal of a triangular segment as illustrated in Figure 9 will answer the purpose while in higher rectoceles it

may be necessary to carry the lines of the excision almost parallel to each other from the initial incision to a point near the cervix. In any case the excision should be carried considerably beyond the herniated portion of the septum so that the uninjured lateral portions of the septum may be used in the reconstruction.

4 *Closure of the hernial opening in the rectovaginal septum.* The hernial opening in the septum is closed by means of interrupted No. 2 chromic catgut sutures which include all layers of the rectovaginal septum, especial attention being given to the approximation of the musculofascial portion of the septum (Fig. 10).

5 *Denudation of the perineum.* When the rectovaginal septum has been closed to the level of the remains of the hymen, the perineum is denuded with the aid of an Emmett scissors as illustrated in Figure 11. Mucosa and skin only are removed. This denudation exposes the retracted portions of the perineum and prepares it for reconstruction.

6 *Replacement of the levator ani and reconstruction of the perineum.* Following the removal of the perineal skin and the vulvar mucosa the index finger of the operator's left hand is inserted into the space which is bounded by the newly reconstructed septum, the levator muscles and the rectum. The rectum is pushed backward and the line of attachment of the levator to the urogenital trigone is located. A No. 3 chromic catgut suture is then passed from point 1 (Fig. 12) just within the fascia of Colles through the entire thickness of the perineum and is made to include the fascial sheath of the levator just where it attaches to the trigone. The needle is then brought out between the halves of the perineum and is re-introduced and passed in a similar manner on the opposite side of the body. Two additional sutures are passed in exactly the same manner at points 2 and 3 (Fig. 12) and are made to include the same tissues as are included in suture 1. In placing such sutures it is at times difficult to locate exactly the junction of the levator with the perineum with the result that the sutures include small amounts of the levator fibers, a condition which will do no harm as sutures so placed will not cause strangulation as do those placed about the bellies of the pubococcygei above the perineum. When the three sutures have been tied the levator muscles have been drawn downward and toward the mid-

line into a normal situation and relationship without the production of any abnormal and objectionable rigid band of muscle between the rectum and the vagina. The muscles have been replaced by traction on their fascial sheaths. The normal V shaped levator cleft has been restored.

In tying the sutures (1 and 3) the retracted halves of the perineum have also been restored to a normal position and to a normal relationship with the associated fasciae.

The fascia of Colles is closed by a continuous suture of No. 2 chromic catgut placed from above downward. When this suture has reached the lower angle of the perineal wound it is carried upward as a subcuticular suture and tied at the top of the wound (Fig. 13).

In view of the fact that the present article is offered as a preliminary report it is obviously undesirable to make any statistical statement at this time covering the end results which have followed its application. It is safe however to state that the operation was devised in the summer of 1923 and was immediately employed with success in the correction of several extremely large rectoceles. Since that time it has been extensively used by nine members of the staff of the Woman's Hospital with consistently desirable results in the cure of rectocele and in the restoration of the levator ani muscle to normal position and function.

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1919

A METHOD OF ASSISTING IN THE TREATMENT OF DISPROPORTION AND A MODIFIED METHOD FOR ESTIMATING THE RELATION OF THE FETAL HEAD TO THE PELVIS

By BETHEL SOLOMONS M D F R C P I DUBLIN IRELAND
M t fth R t d H p tal

SIMPLICITY is the keynote of success in obstetrics and I have obtained much success at the Rotunda Hospital by the following simple treatment of some cases of disproportion

The method is chiefly used when it has been determined by the Mueller Kerr or by my own maneuver that the head will fit in and be delivered by the natural passages. It is also used in cases of both primigravidae and multiparae when there is no fixation of the presenting part and when natural delivery appears likely but when every little help is indicated. It is of special assistance in patients in whom the inclination of the pelvis is greater than usual i.e. the pubis is on a much lower level than the promontory. The head then tends to over ride the pubis and to give a false impression of the amount of disproportion

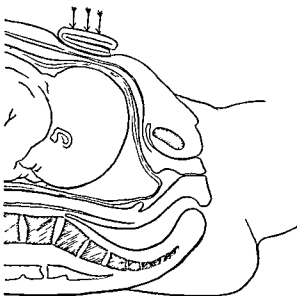


Fig 1

It should be used as a routine in a trial of labor. The method is as follows:

A pad of gamgee tissue is folded in 4 thicknesses 11.5 cubic centimeters in width by 21 cubic centimeters in length the entire thickness being 4.5 centimeters (Fig 1). The head is then put into the engaging position getting as much flexion as possible. The pad is next applied. The

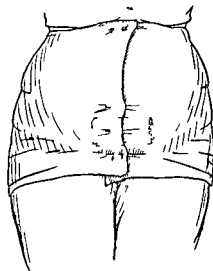


Fig 2

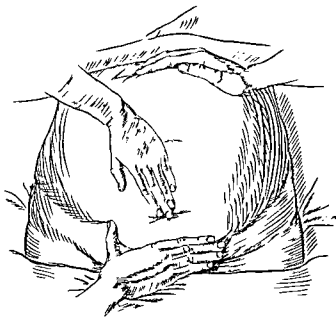


Fig 3

operator holds the pad in position over the fetal head while an assistant applies a tight abdominal binder which is pinned from above downward. Figure 2 shows the pad and binder in position.

When the abdomen is definitely pendulous a pad should be applied in addition to the upper and pendulous part to bring the fetus in the axis of the upper strait.

I have lately practiced the following method of estimating the relation of the head to the pelvis which is a vast improvement on the original Mueller maneuver. The obstetrician sits on the right side of the patient and makes the Pawlik grip while he places the fingers of his other hand

on the fetal head and presses it downward in the axis of the superior strait. At the same time an assistant pushes on the fetal breech from the fundus (Fig 3). If this does not give definite information about conditions the Mueller Kerr modification is practiced.

NLW ANAL INSTRUMENTS

B W D PENNINGTON M D CHICAGO

THE instruments described are (1) a tubular self retaining dielectric cryptoscope (2) a tubular self retaining dielectric anoscope and (3) a bivalve self retaining adjustable anoscope. Each instrument is $3\frac{1}{4}$ inches long. They are flanged at the proximal end and are conical in shape at the distal end so that they may be easily introduced. Each has a shoulder 2 inches from the proximal end to prevent ex-

shock are especially adapted for use by those who treat diseases in and about anal regions with the electric current.

The cryptoscope is composed of the cryptoscope proper an obturator and an insulated detachable lamp and it has a bridge across the fenestra extending three fourths inch from the proximal end to prevent the sphincter from obstructing the view when it is desired to examine

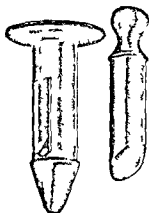


Fig 1. Tubular self retaining dielectric cryptoscope

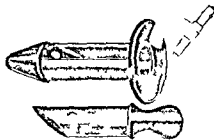


Fig 2. Tubular self retaining dielectric anoscope

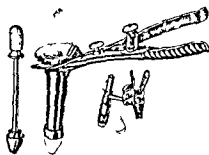


Fig 3. Bivalve self retaining adjustable anoscope

posure on an assistant being thus unnecessary. The cryptoscope and anoscope are made in two diameters three fourths and one inch while the anoscope is made in but one diameter three fourths inch.

Each instrument has a detachable insulated device easily adjustable for illumination of the various fields in the region to be explored examined and treated. The insulation prevents shock in the event of a short circuit. The cryptoscope and anoscope are made of dielectric material and as they prevent the possibility of

and treat the crypts and other diseased conditions which may be exposed.

The anoscope is made up of three parts the anoscope proper an obturator and a detachable and adjustable insulated lamp.

The bivalve anoscope has four parts. The anoscope proper an obturator an insulated and detachable adjustable lamp and a slotted plate and thumb screw for adjustment.

The lamp device which is used in the instrument was invented by Dr D C McKinney of Buffalo.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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SURGICAL PROCEDURES AND RADIUM IN THE TREATMENT OF CANCER OF THE MOUTH AND THROAT

THE use of radium in the treatment of cancer of the mouth and throat is a striking example of the misuse of a very valuable therapeutic agent.

Owing largely to the education of the public by the medical profession many more patients with small chronic fissures or leucoplakia of the lips or minor ulcerations of the tongue or throat are presenting themselves for treatment fearing the possibility of cancer. One rarely sees at the present time a patient with extensive cancer of the mouth or throat who has not been under the care of a physician.

Of equal importance to the education of the public is the education of the medical profession to give the best possible treatment to these patients with early lesions of the mouth and throat.

Before the advent of radium the patient with a suspicious ulcer of the mouth or throat presented himself to a surgeon who excised the lesion either with knife or cautery for microscopic diagnosis. If the lesion proved to

be malignant the gland bearing fascia that drained the area was removed. If it proved to be benign the patient was well rid of the trouble and no further treatment was necessary.

Today such lesions are frequently treated with radium by the radiologist, the dermatologist or the physician with a small amount of radium at his disposal. Following this one of two things may occur. The local lesion clears up entirely only to recur however in the lymph nodes of the neck in a few months or years or the local lesion becomes more active and metastatic nodes appear in the neck. Frequently when these nodes appear the patient has a tooth removed believing it to be the cause. Later the mass in the neck is explored and found to be an inoperable metastatic carcinoma.

In cases of cancer of the larynx removal of the growth by thyrotomy with or without removal of the cartilage or laryngectomy offers the patient the best chance of cure in the intrinsic case. Although radium has been used and is still being used in intrinsic cancer of the larynx the end results are not good and the sloughing of the cartilage which frequently follows is sometimes disastrous. Recently Lortmann and Harmer recommended removal of the cartilage from both thyroid cartilages leaving only a frame of cartilage in order to avoid secondary sloughing and then using radium directly against the growth. Although their results indicate that this may be of use in inoperable cases it should not be used if the lesion can be removed surgically.

In this country radium is generally used in the treatment of extrinsic epitheliomatous

the larynx operation is not attempted Sir Wilfred Trotter of the University College Hospital London performs lateral pharynxotomy which is a great advance in the surgical treatment of growths of the epiglottis aryepiglottic folds and the postcricoid region Trotter reported the results of his first work in 1913 and has since perfected the procedure After removal of postcricoid tumors he reconstructs the upper end of the œsophagus and pharynx with a flap turned in from the neck In many of his cases the condition was entirely cleared up by surgical removal

Radium has however a distinct place in the treatment of cancer of the mouth and throat but it is being used at the present time in the treatment of many lesions for which it is doing more harm than good Patients with rapidly growing extensive cancers of the tongue and nostrum who could not possibly be benefited by any surgical procedure have been entirely cured of their trouble by radium Radium seems to be of help in pre operative and post operative treatment It should not be used however to treat the questionable primary lesion which should be excised for microscopic diagnosis nor should it take the place of the removal of the gland bearing fascia of the neck

What has been accomplished by radium in the treatment of cancer of the mouth and throat has been overshadowed by the number of inoperable cases that have increased at least 50 per cent as a result of its indiscriminate use in the treatment of the primary lesion and of nodes of the neck

GORDON B. NEW

PRACTICE OF OTOTOLOGY IN THE SUMMER MONTHS

THE practice of otology in the summer months varies somewhat from that in other months One difference is attributable to swimming which produces an otitis media especially in poorly cared for hotel

pools that are used by a large number of house guests and by the enthusiasts of the neighborhood In our large cities particularly those on inland lakes most of the public beaches are located in such a way that the shore projects at each end of the beach and tends to form a pocket which prevents to some extent the flow of water in this area Further the lavatories are often not conveniently located on some beaches there are none available so that pollution of the water by bathers who frequently stay on the beach for several hours during the hot days is encouraged

Otitis media from swimming is caused by the entrance of polluted water into the nose and throat This followed by choking or blowing the nose hard force the infected water up the eustachian tubes to the middle ear From experience in dispensary and private practice it seems that otitis media of swimming origin as contrasted with that from acute head colds in winter time is definitely less severe and responds more quickly to early paracentesis and relatively infrequently continues to the stage of surgical mastoiditis

It hardly seems necessary now to suggest that in cases showing definite signs and symptoms of surgical mastoiditis there are several advantages in not operating at the onset of mastoid pain and tenderness In the first place it is not unusual to find that after delaying a few days the mastoid symptoms disappear and recovery is complete without operation Secondly especially is it true that a child may have mastoid pain and tenderness from conditions other than surgical mastoiditis Lastly in unquestionable cases of acute surgical mastoiditis a delay of a few days allows the surrounding tissue and the general resistance to the offending organism to increase greatly Delayed mastoidectomy in cases of uncomplicated acute mastoiditis unquestionably shortens the postoperative course

One symptom which has been found very significant in questionable cases is night pain in the affected mastoid. It is especially helpful in children who frequently have a complicated assortment of signs and symptoms.

Parenthetically surgical mastoidectomy as performed by well trained American otologists is not surpassed by our European confrere.

A visit to the larger centers of Europe during the past spring revealed that our surgical work has a few definite advantages. First our work is less radical yet we do explore when exploration is indicated rather than as a matter of routine. Second we think of the postoperative appearance of our wound and therefore partially close the wound at operation, which lessens the scar and greatly shortens the postoperative course of treatment and healing. Third we are infinitely more mindful that our patient shall not endure unnecessary pain and that he has a definite personal pride and modesty that should be respected.

During the past two summers the great increase in foreign travel has produced some unusual ear manifestations especially in infection of the external auditory canal due to the fungus *aspergillus niger*. Two cases observed were in patients who just returned from extensive travel, one spending 7 months on a world cruise, the other 3 months in the interior of China. A third was found in a man who spends much time traveling in this country. The diagnosis was made from a microscopic examination of the black mass in which

mycelia were found. In each case the patient sought relief from cerumen and returned with the suggestive black thick secretion involving a small area of the canal membrane.

Furunculosis of the canal is also a definite feature of otology in the summer months yet it does not seem to give evidence of any peculiar seasonal variations.

Examination of the deaf shows a marked increase during the warm months. In searching for a reason it seems that possibly the out of door life at this time of year impresses the deaf with their great limitations and so encourages them to seek relief. Also the education of parents and children by the investigation of school children by otologists and the publicity in recent years of our otological societies and their committee has greatly encouraged examination. The mechanical devices for the aid of deafness show a marked improvement which is encouraging in that further refinement will develop as more demand is expressed for this means of relief.

The correction of the mild conduction type of deafness constant or intermittent as found in children due to a partial closure of the eustachian tube from adenoids or mild nasal abnormalities is a striking seasonal feature. Not infrequently inattentive and scholastically poor students are completely changed by relief of their deafness due to treatment of the eustachian tube or indirectly by correcting nose and throat conditions.

HORACE R. LYONS

MASTER SURGEONS OF AMERICA

LOUIS SAMUEL McMURTRY

BORN in Harrodsburg the seat of the first capital of Kentucky on September 14 1850 of Scotch descent Louis Samuel McMurtry was reared and educated in the Blue Grass the aristocratic section of the State and died in Louisville the seat of his labors for over thirty five years on February 1 1924

Danville was long the cultural center of the State and it was here that young McMurtry obtained his academic education receiving his degree in 1870 His alma mater Centre College numbered many distinguished names among its alumni Unquestionably the atmosphere in which he at this time lived must have fired his ambitions and desires and have played no small part in determining him not only to study medicine but to follow in his professional career along the same lines as the immortal McDowell

At Danville McMurtry came early most likely during his academic studies under the influence of Dr John D Jackson a scholar a student a gentleman and a philosopher as well as a surgeon of distinction He read medicine with Jackson for a year or two dissecting the human body and becoming well grounded in anatomy before entering medical college

Is it to be wondered at that he was enthusiastic in his studies or that he graduated after his course at Tulane with the honors of his class? His graduation in 1873 was followed by an internship at the old Charite where he was chief medical resident During this time he presented several papers bearing upon important medical topics His impress upon his professors during these student days was so great that he was invited to make the address to the graduating class 2 years later

Returning after his graduation to Danville he took up the active practice of medicine and surgery With a year's intermission during which time he taught anatomy in the University of Louisville he continued his practice in the community until he moved to Louisville in 1888 These were busy years Although the demand on his time in general practice was very great he continued a diligent student of surgery and was one of the early converts to Listerism having been a student of the work of Pasteur He was a life long admirer of the great French scientist During this period his surgery was not confined as later to abdominal and pelvic work as may be noted by his papers which include the report of a successful ligation for aneurism of the subclavian artery and papers on general surgery



LOUIS S. McMURTRY
1850-1924

As a surgeon of keenest judgment as an operator of brilliant and marvelous technique as a diagnostician of wonderful acumen insight and sound reasoning McMurtry had no superior and few equals certainly in pelvic surgery His early work with that of Price and Kelly has left its mark upon American surgery of today

Doctor McMurtry in addition to his membership in the American Medical Association of which he was president in 1905-1906 was an active member of his state and county societies a fellow of the British Gynæcological Society and of the Edinburgh Society of Obstetricians and one of the founders of the American Society of Obstetricians and Gynecologists of the Southern Surgical Association and also of the American College of Surgeons in which he took a most active interest He was a member of the American Surgical Association and at the time of his death was president of the Kentucky State Board of Health which post he had held since 1919

During the great World War he organized the first unit in Kentucky that saw oversea duty He was appointed by the Surgeon General as Military Aid to the Governor which post he filled until its duties became too onerous

His illness was a short one death being due to pneumonia of four days duration When the time came to join the innumerable caravan he went

Like one that draws the drapery of his couch
about him and lies down to pleasant dreams

LOUIS FRANK

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BLOWN, M.D., F.R.C.S. (LOND.)

THE MEDICOSURGICAL OBSERVATIONS OF PIERRE MARCHETTI

AMONG the numerous surgical Observations published during the seventeenth century the little book of Icturi de Marchetti or Pierre Marchetti takes high rank for though small in compass physically it holds between its cover in epitome of the advance that surgery had made during the preceding century. Marchetti was born in 1589 just as Pare was passing off the surgical stage and lived until 1673. A native of Padua he became first professor of surgery and later professor of anatomy at the University where he was distinguished as a fearless and clever operator.

In 1664 his *Observations* appeared according to Haller sixty eight in number but the volume illustrated here was published in 1665 and contained but sixty three. Following these are small books entitled (a) Concerning Fistulas of the Anus and Rectum (b) Concerning Ulcers and Fistulas of the Urethra and (c) Concerning Spina Vento. The book is entitled A syllogism of the rare medico-surgical observations of Icturi de Marchetti of Padua Knight of St. Mark formerly professor of surgery and now professor of anatomy in his native University Amsterdam from the workshop of P. Triet Grand 1665.

The great interest displayed in wounds of the head is particularly prominent in all the surgeons of the sixteenth and seventeenth centuries. Other forms of operative work like the stone and hernia were left to the barber surgeons and chiropractors but for some reason or other these head wounds were considered in the domain of the educated surgeon. In all parts of Europe there was constant warfare and war meant hand to hand fighting so that club came into use and broken heads were common. Thus material for observation and treatment was abundant but does not seem to have been used for scientific purposes. The surgeon advised trephining and if he wrote a book or treatise described his instruments and technique after which he considered his work done. From Brunschwig on there are illustrations of trephines and saws the prognosis and differentiation between concussion and compression are hinted at as by Berengarius but of detailed examination with the findings there is little said.

Marchetti in his clinical observation excelled his predecessors. A report of one of his cases reads almost like one of the present day and while in many

of these illustrations is difficult Marchetti places his material before the reader so carefully that a diagnosis can be hazarded with pretty fair confidence that it is correct. If he drew any conclusion from his clinical data he did not publish them nor make any attempt to establish the relation between cause and effect. This is seen particularly in his Case V a brain case in which by his description he uncovers the key to cerebral localization but then stops and says nothing more. He describes the case as a large wound of the right side of the head in which a multipiece of bone was driven in through the membrane into the brain and on this account above the other symptoms common to the case this was the symptom proper to this wound. Finally as the opposite arm and tongue

that he was all neither to speak nor move the right arm for 30 days Marchetti tried all sorts of treatment in the way of dressing and ointments without avail. He then decided that a piece of bone was present which having been grasped by a volsellum I drew out to it was attached a portion of the pia membrane and of the brain whence hardly half an hour later he covered the motion of the tongue and arm. Several other brain cases are described with equal care one of particular interest in which traumatic epilepsy was cured by removal of a piece of bone. He believes that unless the signs of compression are present cranial wounds are not particularly dangerous. This portion of the work reveals the author is a urgeon of excellent judgment and it is a disappointment to find later that Marchetti believes in the Galenic doctrine that nerves and tendons should not be sutured because of the vital fluid that flows through them and attacks Severino for advocating suture of the structures. He says

Indeed I have seen nerves or tendons unguardedly sutured by certain Barbers followed by convulsions and the death of the patient. He publishes only one illustration which represents a thumb bitten off by a horse with avulsion of the flexor tendon at its junction with the belly of the muscle. It is a little difficult to understand why this case should have been singled out for illustration.

Marchetti's conclusions about penetrating wounds of the chest are remarkable in that he lets them alone unless indications for active interference arise. He operates upon patients suffering with empyema so his expectant treatment is dictated by judgment and not by fear.

REVIEWS OF NEW BOOKS IN SURGERY

THE reviewer must plead guilty of profound skepticism when reading current texts in surgery since libraries contain a number of single volumes and brief systems dealing with this general subject. It would seem that the material and its presentation must be exhausted in a day yet books continue to appear and are readily recommended by the publishing houses that more are forthcoming. Truly surgery has made great strides in the past two decades and must continue to advance to meet the ever changing demand of the biologic and pathologic responses of a fickle human race. So long as revisions and new works keep abreast with the times or better still add to or illuminate the newer thoughts which have had thorough investigation and trial then there is a place for them but simply a rehash of the old cannot hold its own nor can a superficial vague and indistinct delineation be accepted. Texts must keep abreast with the times and must exceed other obsolete

THE second edition of volume II of *The Operative Surgery* by Rolands and Turner is before us. This volume is devoted entirely to the abdomen. A careful study of this book indicates that it is not only a peak of text of operative surgery but rather a text of the treatment of surgical diseases. The approach to the subject material is planned in a rather unique way in that the disease is briefly discussed from the standpoint of the etiology, symptom, and diagnosis of a specific pathological process then the description of the pathology and the most natural manner to its treatment. Instead of recommending certain of the stomach for carcinoma the authors discuss carcinoma of the stomach as seen at the operating table taking into consideration such factors as secondary growth in the viscera, peritonitis, and the site and size and degree of fixation of the growth. Upon these factors depend the type and extent of operation for a operation is indicated. The operations are painstakingly described innumerable details so essential to success being included. This scheme of description is most lucid and makes for a clear understanding of the treatment of a specific condition. Many excellent illustrations further clarify the text. The authors have shown wisdom in their selection of salient points in the general discussion of diseases. The amount of information given in so few words is remarkable.

A careful reviewer recalls only one omission of note. In the chapter describing the treatment of perforated peptic ulcers the collapse of the lung is not mentioned. The bizarre onset of this condition

and not infrequently the dramatic relief which is afforded by means of perforation is well deserving of mention.

J. A. WOLFE

THE first volume of *Levi's Practical Surgery* to come from the press is numbered. This system is to consist of 10 volumes covering the entire field of surgery and is to be prepared by a large number of contributors each having given special attention to his subject. The science of surgery has advanced so rapidly in the past decade or two that many so-called general surgeons specialize in certain branches. This is more or less of a necessity due to the tremendous development of the various branches of surgery including the physiologic, biochemical and physical aspects. A good illustration of such specialization is the Registry of Bone and Spinal Surgery under the guidance of the American College of Surgeons and the intensive study of such material by Kolodny's recent monograph bearing a monumental achievement for American surgery. There is no question but that such specially equipped men are well prepared to present their topics because of their intensive study of the clinical and experimental as well as the literary aspect of their topic.

A number of years have elapsed since such a comprehensive work has been attempted and it is only timely that such a system should be prepared for the medical profession especially when it is edited by a man of the scientific attainments of Dean L.

This first volume to appear is devoted to bone and joint. This is an excellent chapter on bone tumors. This brings to the reader in a comparatively brief and lucid manner the subject as it stands today. Osteomyelitis is presented in a very striking and detailed fashion. The reviewer has never seen a complete and clearly an exposition of the subject correlating pathology, symptoms, and treatment. Injuries and diseases of the joints are equally well presented. Probably nowhere in any language can so thorough a delineation of the subject be found. This applies especially to bony aneurysms which so little is known by the average medical man. These chapters are most exhaustive.

A casual survey of the chapters on fractures would lead one to believe that the subject is inadequately covered. Yet Cotton in his characteristic manner backed by his tremendous experience and keen acumen in such a place as is allotted to him hits the mark every time.

This volume speaks well for the editor and his contributors and indicates that soon a most comprehensive and thoroughly modern system of

surgery will be available for the medical profession. The volume is loose leaf so that material may be replaced from time to time as advance is made in the art and science of surgery. J A WOLFER

THE first edition of *Emergencies of a General Practice* which was published in 1918 by the late N C Morse has been revised and rewritten by Amos Watson Colcord. It deals with the class of work in which the attending physician is called on to think quickly and to act with rapidity and good judgment. The thirteen chapters contain much interesting information and the description of methods which the writers have found best. The subjects considered include removal of foreign bodies, first aid treatment of asphyxiation, surgical emergencies, medical emergencies, fractures and dislocations, amputations, obstetric emergencies and various types of poisonings.

The propriety is questionable of including in a book of this type the brief descriptions of such surgical procedures as gut resections, treatment of ruptures of liver, spleen and pancreas, of acute appendicitis, of ruptured ectopic pregnancy, of strangulated hernia, caesarean section and the wiring of teeth for fractured mandible.

On page 120 F 361 shows a proctoclisis outfit which is captioned: Meinecke's hypodermoclisis apparatus. On page 127 Colcord says that no doubt the permitting of first aid classes to dress wounds has been productive of much wound infection. He found that one third of this infection had been first treated with iodine.

The writer seldom boils his instruments but is content to sterilize them in denatured alcohol slightly over neutralized with caustic soda. In his opinion a general anæsthetic is nearly always necessary in the removal of needles. In his discussion of poison ivy (an emergency?) the writer makes no mention of the antigen treatments.

Although this volume is interesting it is a far cry from Lejar. FREDERICK CHRISTOPHER

IN a very excellent monograph² Fitzwilliams has presented the modern surgery of the tongue. It is based upon a wealth of material from the London hospitals and the literature. The chapter on macroglossia and fissures of the tongue is full of interest and very complete. Other chapters include injuries, inflammations, leucoplakia, syphilis, tuberculosis and actinomycosis of the tongue. There is a discussion of submaxillary calculus, ranula and thyroglossal tumors and cysts.

Of greatest value is the one hundred pages devoted to cancer of the tongue. In his preface the author says that cancer of the tongue is one of being

the hopeless disease that the laity and many physicians and some surgeons seem to think it is just as curable in its early stages as is cancer elsewhere. It is a duty therefore for each medical man to instruct the public as to the curability of cancer when recognized and treated in early stages. The clinical characteristics of the hard edged ulcer and the papillomatous excrescence are clearly brought out.

The author favors surgical methods which he fully describes but includes an account of treatment by diathermy, radium, X rays and various other methods.

The text is clearly written and made more vivid by the many illustrative cases. It is a book full of interest to every medical man and may heartily be recommended. FREDERICK CHRISTOPHER

DR SLUDER has limited himself in *Nasal Neurology, Headaches and Eye Disorders*³ to a description of nasal diseases which have as symptoms headaches, eye disorders, neurological phenomena of nasal origin controlled by nasal treatment and neurological phenomena apparently not of nasal origin but controlled by nasal treatment and orbital abscess. There is here epitomized numerous articles he has published on rhinological problems with the hope of securing the interest and co-operation of ophthalmologists, neurologists and internists on obscure problems connected with rhinology.

A clear idea of some of the fundamental facts on which Dr Sluder's deductions are based is given in the introductory chapter by Dr Jonathan Wright on the minute pathological anatomy of changes observed in nasal tissue chiefly from material from Dr Sluder's cases.

The chapter on vacuum frontal headaches is of great interest. Dr Sluder distinguishes two types, one a symptom of a disease which is easily recognizable and limited by the duration of the disease, the other arising in some obscure condition of which the headache is the only symptom. It is with this headache that he is chiefly concerned and it is in such cases he believes the rhinologist can help. Such headaches are relieved by cocaine, permanent or long continued relief can come from astrinents but removal of the anterior part of the middle turbinates may be required.

About 50 pages are given to a detailed account of the syndrome of nasal ganglion neurosis. The description of the sphenopalatine ganglion with its anatomical relationship is full and clear. The ganglion is easily reached since it is very constantly placed above the posterior tip of the middle turbinate and is separated from the nasal cavity by a small amount of areolar tissue and the nasal mucous membrane.

The discussion on hyperplastic sphenoiditis which extends over 100 pages may be read with advantage.

EMERGENCY A G NERA F CT By th l t N th Cl k
M AB MD FACS R d tt by Am W t
Col d MD d J St Lo C V Mosby C 97
Tn ND 1 DISEA S Dy D C L F Lz ll m
CMG MD Ch M F R C S 97 d E g N w y k d Lo
O d d U ty P ess 97

N N O HEA CH SAND F D By G Gld
Sl d MD FACS St Lo S Th C V Mosby C 97

One is not amazed that sensory phenomena can arise from disease in it but that they are uncommon in the experience of many competent neurologists. The question may well be asked: Are such disturbances unrecognized?

The relation of the vidian nerve to the base of the cell is the cause of many of the syndromes, especially those with widespread pain extending from the masseter to the arm and hand. Operations in such cases, by means of surgical dissection, as Dr. Sluder insists, should not be undertaken without a thorough knowledge of the anatomy of the parts and a considerable degree of surgical skill. This chapter concludes with a description of the author's technique.

The chapter on rhinological problems in rhinology is devoted to a large extent to phenomena not easily explained. Many are reflex phenomena associated with the fifth nerve, others in olfactory opinions regarding the role of the sympathetic. The interesting chapter must be read in its entirety until we know more about the sympathetic nervous system; our belief will be more speculative than real.

The work, the result of years of study by a patient, taking an indefatigable order in rhinology and a notable contribution to medical literature.

J. G. R. D. W. L. S.

If we have difficulty to make a definition of minor surgery. All minor surgery is potentially major surgery. A slight nasal incision cannot be made. Not infrequently more judgment and more delicate surgery is required for the surgery than needed for the standard laparoscopic appendectomy or hysterectomy.

Practical Clinical Surgery the writer has collected a suitable encyclopedia of format, a first interest to surgeons, practitioners, students and nurses, but which exceeds the limits to which the reviewer should restrict the title of minor surgery.

The first part of the chapters includes the nursing care of the bed patient, the use of inhalations, the various types of enemata, the administration of hygienic and antiseptic measures, the treatment of syncope, pharyngeal, pyroperative, and postoperative treatment, attention to lavage, catheterization, etc. The collection of six chapters take up the procedure to the operation. Method of sterilization, preparation of the hand, the operation, the use of instruments and the type of anesthesia. A minor surgical procedure, sutures and the repair of the incision, cauterization, ligation, and the treatment of a dental wound, etc. discussed.

The third part devoted to the surgical diseases and the material for describing and the technique of their treatment, coupled with an excellent chapter on antiseptics. Bandages, slings, and dressings are thoroughly considered. The fourth part contains six chapters devoted to the apparatus and physiological therapy employed in the treatment of fractures.

The description of the paraphernalia for traction and suspensions seems inadequate. The one hundred and twenty pages given to the treatment of special fractures comprise an excellent compend of the subject, although fractures of the femur and spine scarcely have place in a minor surgery and omits depiction of skeletal traction. Part five deals with the joints and includes sprains, joint effusions, dislocations, and some account of orthopedic treatment. The sixth part includes the lesser gynecological procedure and catheterization. Part seven take up the lesser surgery of the eye, nose, ears, larynx and mouth.

The volume represents a great amount of serious effort and contains a mine of valuable information. Certain omissions and scope which exceeds the title do not prevent the reviewer from according it hearty praise and commendation.

F. E. ICK, CHRS. H. R.

In his monograph of 8 pages Roche begins with a historic review of pyelography followed by a detailed discussion of the various solutions which have been used in this work from the beginning to date.

The matter of technique is given in detail attention being centered on the danger which may arise from its faulty execution. To avoid the possibility of court litigation the author is careful as regards the selection of case for pyelography. So decidedly opposite is his to pyelography as a routine procedure that he states emphatically that it should never be resorted to except when a diagnosis can not be arrived at by other means.

The various reactions following pyelography are discussed as well as the different methods for their prevention. Indications and contraindications are judiciously considered.

A very good detailed description of the normal pyelogram is given. The author wisely calls attention to the great difficulties at time encountered in the reading of pyelograms.

Descriptions of the various pyelograms as found in the presence of stone, tumor, tuberculosis, inflammation, conditions, etc. a discussion of the value of pyelography in the differential diagnosis of obscure abdominal pain and of the value of pyelography in the presence of shadows in the X-ray plate and the relationship between the occurrence of abdominal tumor and the kidney, pelvis and ureters. The author states that in carrying out an account of his excellent judgment and his commendable conservatism.

This book is a most commendable classical essay and will be a great help to all who wish to familiarize themselves with the technique of indications for pyelography and the dangers which may follow its use.

H. L. K. TSCHMER

P. LOG. PH. ITS II. T. CL. U. L. D. D. By
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PAPIN surgeon of St Joseph's Hospital in Paris has just completed a beautiful two volume work on surgery of the kidney. The author has brought the literature on each subject up to date. However it should be stated that the bibliography is almost entirely French with some mention of German and less mention of English and American workers. The normal anatomy of the kidney, gross topographical and microscopic is given many pages and is illustrated with colored plates. Special attention is given to the kidney pelvis, calyces and blood supply of the parts.

To correlate his excellent chapter on renal anomalies the author first enters into a clear description of the development of the kidney. He deals at length on the anomalous blood supplies of kidneys.

Nitrous oxide gas with no preliminary sedative seems to be the favorite anesthetic however much ethylene is also used. Regional anesthesia is briefly described.

After discussing the instruments used in renal surgery he writes in detail the indications for and the technique of each method of approach to the kidney. The lumbar extraperitoneal route is usually given first choice. The author recommends nephrotomy for exploratory purposes and concludes that its effect upon the renal parenchyma is a slight loss of renal tissue through scar but the remainder of the renal cells undergo compensatory hypertrophy.

Posterior and anterior pyelotomy are stressed from the viewpoint of producing hemorrhage in injured anomalous or supernumerary blood vessels. However all kidney pelvis work seems to be in agreement with recent American ideas.

In nephrectomies separate ligation of the renal vessels is preferred. Clamps which are left on the pedicle are used only when nothing else can be used. In secondary nephrectomies the subcapsular method is recommended. Adhesions, large kidneys, hemorrhage, abnormal vessel, wounds of the inferior vena cava, opening of the pleural cavity, wound of the diaphragm and nerves, opening of the peritoneum and intestines and injury to the suprarenals are all pointed out as complications of nephrectomies. Immediate postoperative accidents are operative shock, anuria, hemorrhage, hemothorax and wound infections, late accidents are fistulae and hernia of the abdominal wall.

In nephrectomy for tuberculosis the author advocates complete removal of the fatty capsule, cauterization of the ureteral stump and drainage of the wound.

For nephropexy the methods of Guyon and Edebohl are mentioned first. The author supplements their methods by using the fatty capsule for a basket to maintain fixation. Plastic operation on the kidney pelvis are fully described but no opinion is given as to the efficacy of the different methods of procedure.

Surgical procedures in nephritis include decapsulation and omental implantation of the kidney. Experimentally better results are obtained with the latter procedure.

The author concludes that unilateral ligation of a ureter always causes hydronephrosis of the same kidney with a toxic nephritis of the opposite organ. Bilateral ureteral ligation causes death of a uraemic nature. Ligation of any renal artery, small or large, causes death of that portion of the kidney tissue supplied by the ligated artery. Anomalous vein or even the renal vein can be ligated with a rather satisfactory formation of collateral venous circulation.

It is stated that in all methods of diverting the urine through path other than the bladder that is leaving the ureters to the skin or transplanting the ureters or entire trigone into the bowel at various sites always leads to a certain degree of hydronephrosis and a certain amount of pyelonephritis. The illustration of ureteral transplantation are well worth reviewing.

These two volumes are highly recommended to anybody with increasing knowledge of French and who is especially interested in surgery of the kidney.

HARRY CULVER

THE past years have seen a material change in the literature of malignant tumors. Previous to this time much attention was given to various theories of the origin of tumors, the best known of which was Cohnheim's theory of embryonal tissue development. All of the theories were largely the result of abstract reasoning based upon histological observations. In this study of the etiology of malignant tumor tend to ignore histological material and to be directed along three different lines of investigation: (1) the transplantation of tumor from one animal into another; (2) the relation of heredity to the incidence of tumors; and (3) the experimental production of tumors in lower animals.

LEWIS in this volume* of 231 pages has reviewed the literature on the etiology of malignant tumors. The extent of his labors is indicated by the fact that at the end of the volume is a bibliography of 3,600 closely printed pages giving references only and not titles of the articles cited. American medical literature is rather well represented. Carrel, Jörstid, Lambert, Levin, L. Loeb, Murphy, Rous, Slye, Tizzier, Woggon and Wells each has one or more citations. The author is convinced that regardless of any possible microbic origin the problem of the etiology of malignant tumors stands in close relation to immunobiological processes. In the development of malignant tumors there are two factors, namely, an extrinsic factor (irritation) and an intrinsic factor (inherited disposition including immunological phenomena).

D. AET. OGE D. B. E. F. V. G. CHWU. STE. CH. D. M.
C. M. TE. L. F. R. S. DE. KLINSCHEN. E. ND. ND.
J. I. P. LE. F. R. S. CH. NG. By Fr. Ies. D. C. I. L. W. Le. I.

The book is divided into five sections. After a short introduction the author considers at some length (17 pages) the theories of tumor formation and their experimental basis. In this section include the experimental evidence that has been established for anlagen and the old theories of Virchow (hohem Ribbri and others). Following this he discusses tumors induced by mechanical irritants such as diathermy, caustic light rays, alum, etc. Thirty-six pages are devoted to a consideration of carcinomata induced by chemical irritants. Finally 30 pages to transplantation of tumors and 36 pages to parasites as causes of malignant tumors.

In the third section of 30 pages are considered the endogenous factors in tumor formation—constitutive disposition, hereditary and acquired immunity. In this section the author's work on the relation of the relation of the endocrine glands, age, race, and cell disposition and to tumor formation and finally the biochemical basis of the disposition and the immunological phenomena of malignant tumors.

The fourth section (5 pages) is devoted to a discussion of the nature of the action of irritants and includes the morphological and biochemical changes in cells and the biology of malignant cells and their relation to the culture.

The fifth and final section of 10 pages is a statement of the author's conclusions. It is not considered any of the morphological changes in cells of a malignant tumor, a sign of malignancy. It is pointed out that the histological changes in the cell are the result of malignant transformation. The author states that the changes may be the result of the transformation.

The author's conclusions are summarized in a table. It is noted that the enormous literature on the subject of malignant tumors is a satisfactory bibliography. It is noted that the author's conclusions are based on the study of the literature. It is noted that the author's conclusions are based on the study of the literature. It is noted that the author's conclusions are based on the study of the literature.

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nutrition in infancy and childhood will find in this work his foundations.

While encyclopedic in scope it is peculiarly original and stimulatingly unconventional throughout. To those still struggling with a foreign language its simplicity of diction will have an especially appealing. The position of this volume is a unique fundamental to the entire literature.

J. PH. BREAN

In a short clear and well arranged book Tyler and Little have evidently men of wide clinical experience—have dealt with the diagnosis and medical treatment of disease of the lungs. The book is written for the clinician, an emphasis is placed upon clinical signs and symptoms rather than upon micropathology, bacteriology, etc. The book has been written for the senior student or the young practitioner.

There are no illustrations, charts or roentgenograms. In the book written in 1927 the authors have available themselves surprisingly little of the advantages of surgery in the treatment of disease of the lung.

R. PH. B. TRIM

In 1890 long before the value of the collapse treatment of the lung for tuberculosis was generally appreciated, Stuart T. Dey conceived the idea of stripping the chest wall with adhesive for the purpose of aiding the natural process of healing by reducing the mobility of the lung and by relieving the fixed part of the natural pull exerted by the chest wall. The beneficial results which he obtained prompted him to bring the matter to the attention of his medical colleagues in an article which was published in the *British Medical Journal* in 1896.

Twenty years later he met Dr. F. Lanini and was invited to visit the great Italian at his clinic which was small having only twenty five beds and the cases were treated with artificial pneumothorax. Late he came to the conclusion that the results of the artificial pneumothorax treatment from which the following are quoted. It is that in America some other physicians such as Lemke and Schnell following Murphy have carried out the same treatment and in London all quote the results of the original author and no one remembers my name so that the method to which I have preferred is called by all Murphy's method. I am, however, not at all satisfied with the results of the treatment.

Murphy's method is a simple one. It is to obtain a partial collapse of the lung by the removal of air from the pleural cavity. This is done by the use of a needle or a cannula inserted into the pleural space. The results of the treatment are usually good. It is noted that the author's conclusions are based on the study of the literature.

The author's conclusions are summarized in a table. It is noted that the enormous literature on the subject of malignant tumors is a satisfactory bibliography. It is noted that the author's conclusions are based on the study of the literature. It is noted that the author's conclusions are based on the study of the literature.

ment at intervals of several months. And this is the reason that his results are not encouraging.

In this day when the method of treating unilateral phthisis by extrapleural thoracoplasty has been so widely accepted and the method of artificial pneumothorax so well understood this booklet by Tidey must be regarded more in the light of a delightful bit of historical reading even though his indications and his rationale for stripping the chest with adhesive are as good and sound as they ever were.

The reviewer is pleased to have had the opportunity of reading this little monograph and is sure that any one interested in the subject of tuberculosis will also enjoy it.

RALPH B. BETTMAN

RIVIFRE in an excellent little book has described the history, indications and technique of artificial pneumothorax in the case of pulmonary tuberculosis. A short article dealing with other surgical procedures such as phrenic excision, pneumolysis and extrapleural thoracoplasty is appended.

The description of the technique is very good and if the reader would adhere to the method and precautions laid down dangers would be minimized to the lowest possible point. The book is in all senses of the word a practical handbook, although the reviewer feels that it could be made even more practical by the inclusion of additional illustrations, roentgenograms and photographs.

RALPH B. BETTMAN

T. P. MOTH BAK A D S T. THE T. I. L. d
T. B. C. O. By C. R. M. D. (Lo d) F. R. C. I. d d
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THE more one sees of practical surgery the more one is impressed by the relative frequency of unforeseen complications and when one carefully thinks out the cause of the troubles it is only to find that most of them could be prevented. This statement in the preface of Watson's book on the *Fundamentals of the Art of Surgery* expresses the underlying sentiment of the volume. The author definitely states in regard to operative skill. The success of an operation depends on much more than this: it entails first a careful and thorough examination of the patient; second, an adequate preoperative preparation; third, a careful anaesthesia and an equally careful selection of the anaesthetic; fourth, the proper organization and equipment of the place for the operation; fifth, due appreciation of the powers of the patient and his ability to stand the strain to be imposed upon him; sixth, adequate facilities for postoperative treatment and lastly, directions for the after care of the patient. These are the topics discussed by the author. His presentation is excellent in that he combines definite information with sufficient of the romance of medicine to make easy and delightful reading.

It may be discreet to call attention to an error on page 240. The author states that Bayliss advises the use of a 6 per cent solution of gum acacia in 9 per cent sodium chloride solution to be given intravenously. This no doubt is a typographical error and should read 0.9 per cent sodium chloride solution.

J. A. WOLFER

F. D. M. T. A. S. B. J. H. H. W. t
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BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledged merit must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

POLYOMYELITIS WITH SPECIAL REFERENCE TO THE TREATMENT. By W. Russell MacAusland. M.D. Philadelphia: Lea & Febiger 1927.

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LE FRATTURE DEL GOMITO. By Dott. Franco Rosi. (Publication of the Clinica Chirurgica Della Regia Università di Milano.) Milan: Coop. Grafica Degli Opera 1927.

LAS PLRITONITIS POR PERFORACION. By Dr. Elpidio Sincera. Habana: Compania Impresora Industrial 1927.

BIRTH STILLBIRTH AND INFANT MORTALITY STATISTICS FOR THE BIRTH REGISTRATION AREA OF THE UNITED STATES. 9. Eleventh Annual Report—Part I: Summary and Rate Tables and General Tables. Washington: United States Government Printing Office 1927.

THE ART OF ANESTHESIA. By Paul J. Flagg. M.D. 4th ed. rev. Philadelphia and London: J. B. Lippincott Company 1928.

LEHRBUCH DER ROENTGENDIAGNOSTIK MIT BESONDERER BEACHTUNG DER CHIRURGIE. Edited by H. R. Schmin with the collaboration of W. Baensch and I. Friedl. Leipzig: Georg Thieme 1928.

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